ThoraCool*: Cooled RF for the Treatment of Chronic Thoracic Facet Pain

ThoraCool Pain Management System Product Training Presentation

Prevalence

- The z-joint may be a source of pain in 34-48% of patients with chronic thoracic pain
- “Pain in the thoracic region is a common complaint which can be as disabling as cervical or lumbar pain.” (Edmondson and Singer, 1997)

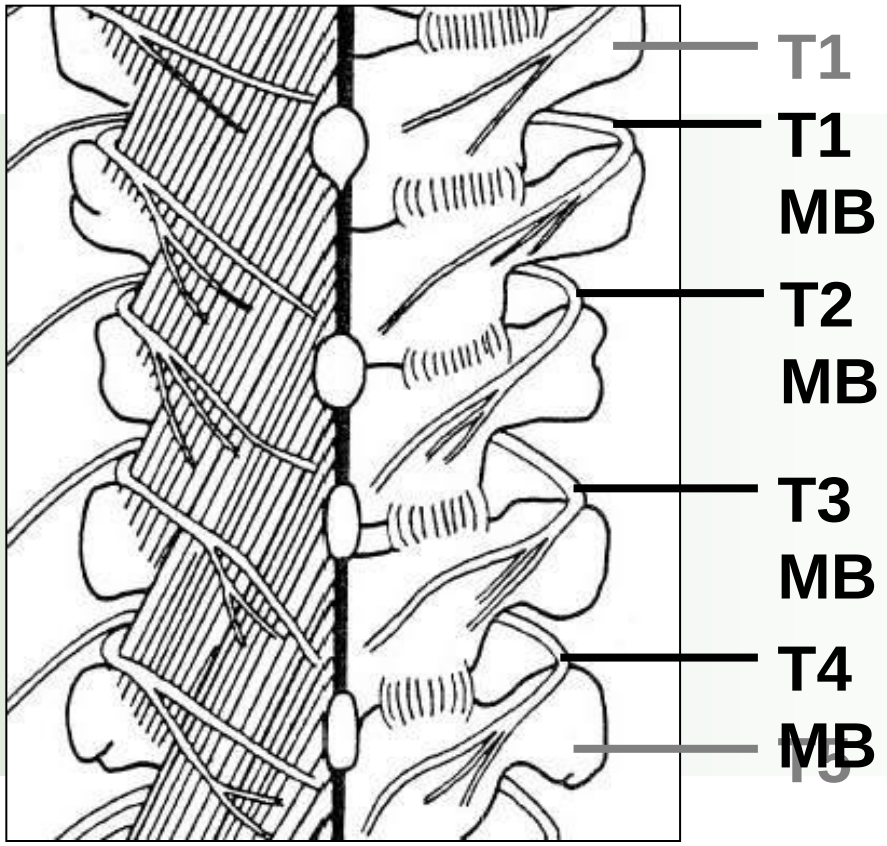
Manchikanti et al. Pain Physician 2002;5:354-359
Manchikanti et al. BMC Musculoskelet Disord 2004;5:15
Manchukonda et al. J Spinal Disord Tech 2007; 20:539-545
Edmondson SJ, Singer KP. Man Ther 1997; 2:132-143.

Anatomy

Thoracic Dorsal Root Nomenclature

- Dorsal root medial branch (MB) travels inferior to the vertebral body of that level.

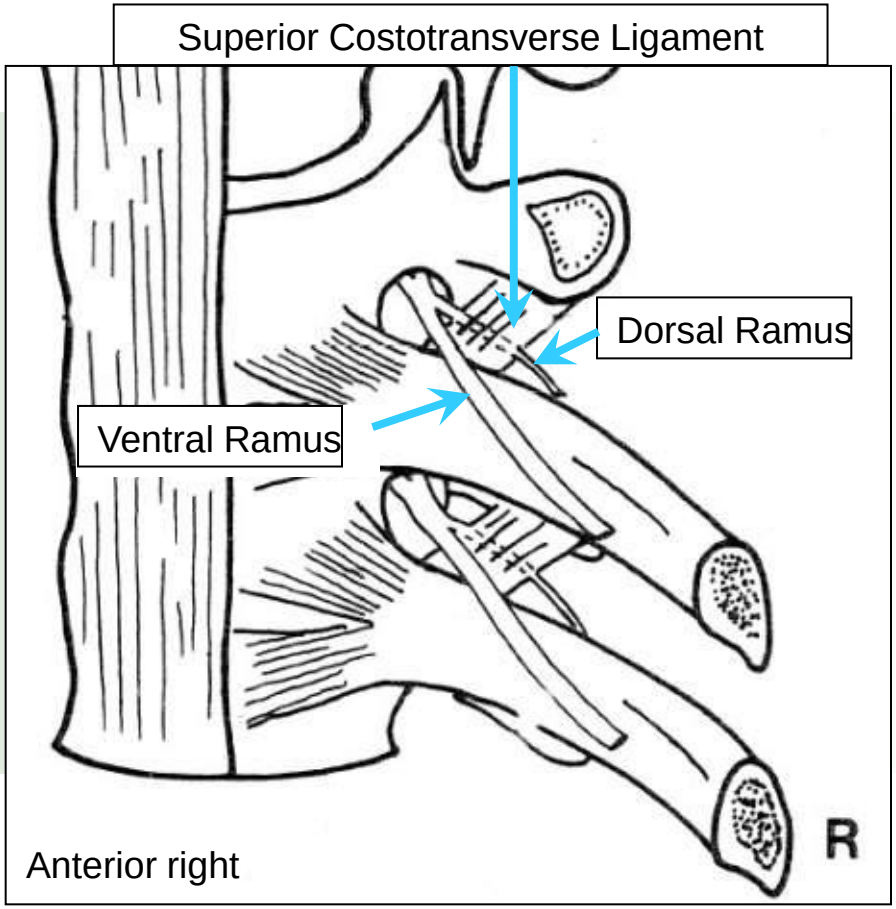
  - T1 medial branch travels inferior to the T1 vertebra and contacts the T2 transverse process below.



Adapted from Fig 2.15 of Chua Thesis 1994

Thoracic Dorsal and Ventral Rami

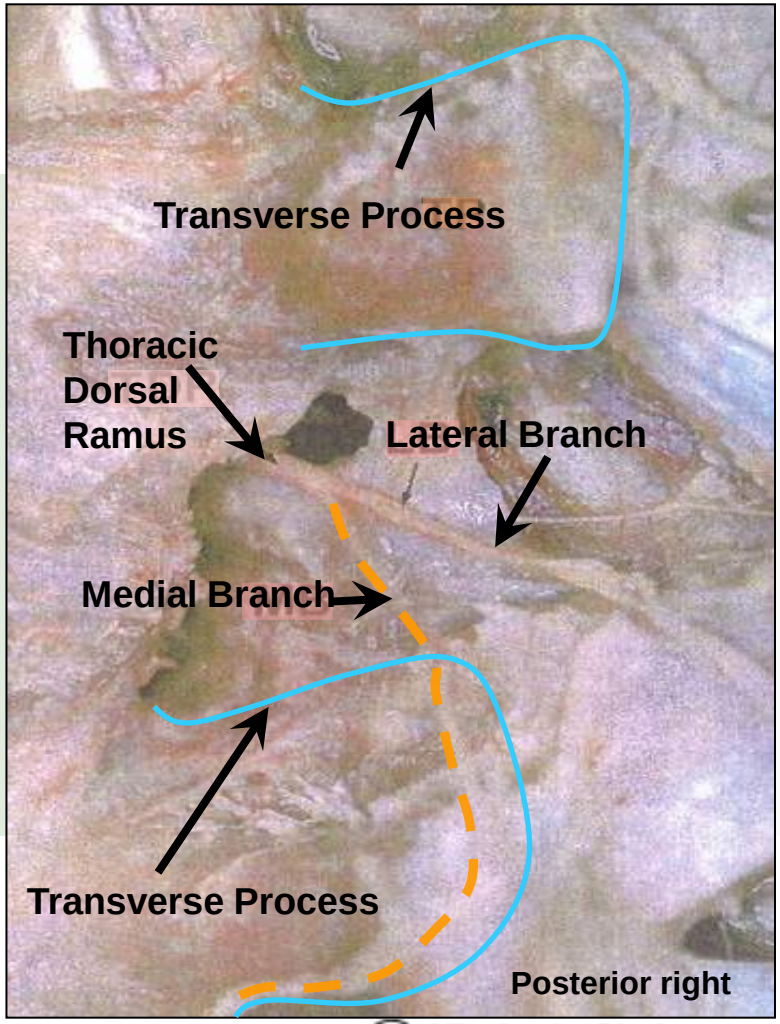
- The superior costotransverse ligament acts as a partition to separate the dorsal and ventral primary rami.



Adapted from Fig 2.6 of Chua Thesis 1994

Dorsal Rami in Transverse Space

- Initially, each dorsal ramus passes through an osseofibrous canal, and dorsally to enter the transverse space.
- Within intertransverse space, dorsal ramus travels 1-2 mm before dividing into lateral and medial branches.



Adapted from Fig 2.8 of Chua Thesis 1994

Lateral Branches of Dorsal Rami

- The lateral branch gives rise to several filaments, which ramify into the following:

  - Dorsomedial aspect of the levator costae
  - Longissimus cervicis and thoracis
  - Iliocostalis cervicis

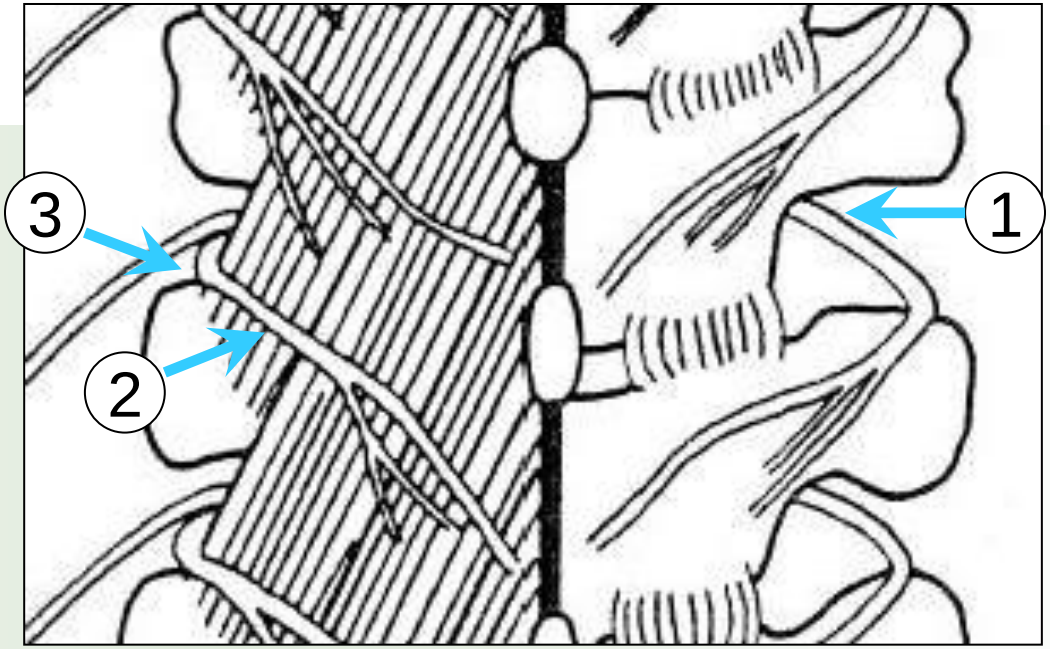
Medial Branches of Dorsal Rami

- The medial branch innervates:
  - -Z-joint joint
  - -Multifidus
  - -Spinalis thoracis, splenius cervicis, rhomboids and trapezius (upper levels only)
- The medial branch follows a general path which displays certain level of variability between individuals, and between different levels in the same individual

General Course: Thoracic Dorsal Rami MB

1. Initially, the MB passes dorsally, laterally and inferiorly within the transverse space, inferior to the corresponding lateral branch.

2. Branches run caudally along posterior surface of transverse process, lying in the cleavage plane between the multifidus origin anteromedially and semispinalis postero-laterally.



Adapted from Fig 2.15 of Chua Thesis 1994

3. The medial branches enter the posterior compartment of the back by crossing the superolateral corner of the transverse process.

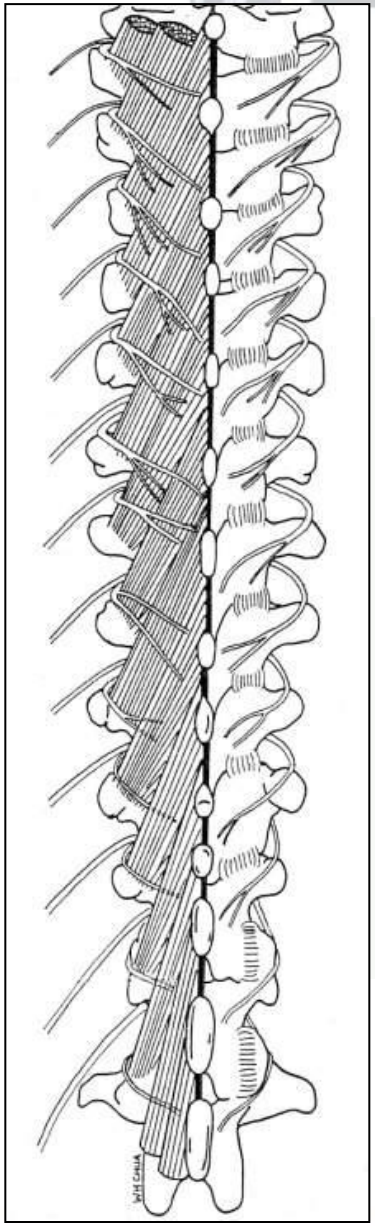
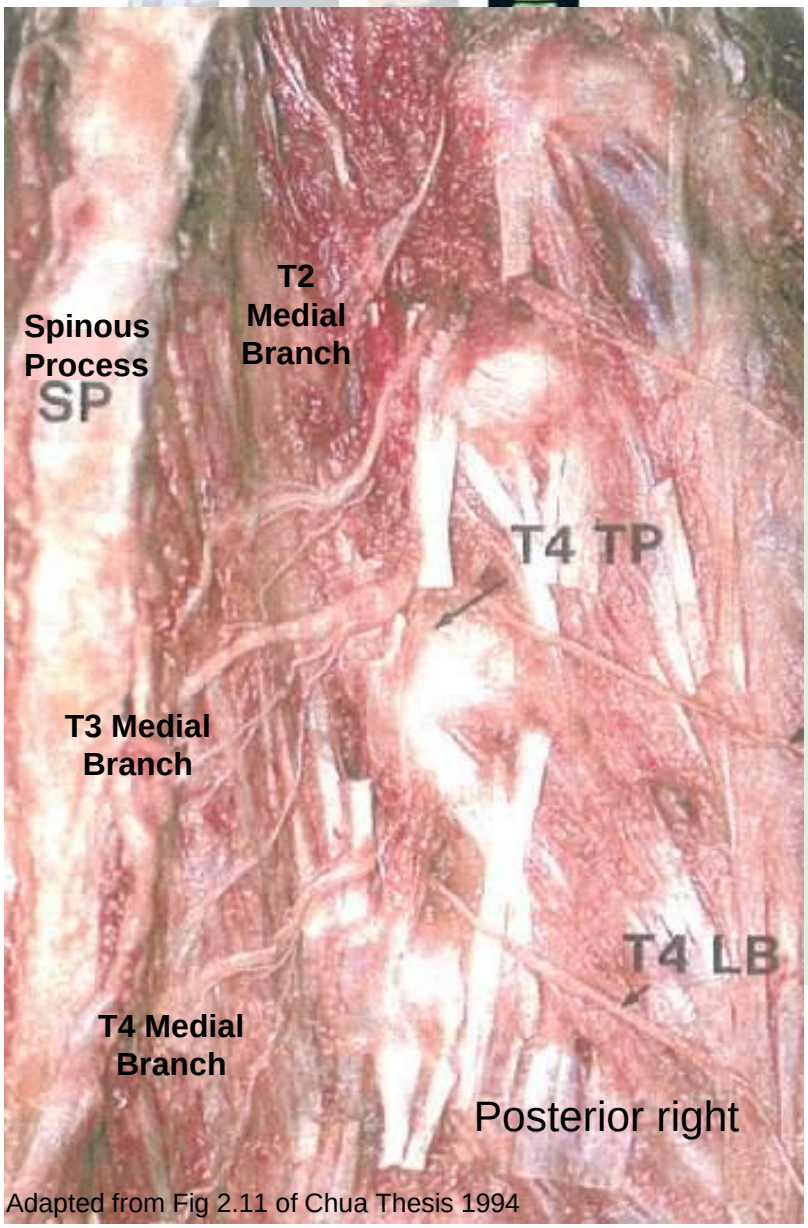


Fig 2.18 of Chua Thesis 1994

Variations in MB Path

- There are many variations of the general path for the thoracic medial branch.
  - Variations observed in individuals between different levels, and sides.
  - Variations also observed between individuals.
  - Regions display a distinct MB innervation pattern:
    - T1-T4, T9-T10
    - T11
    - T5 -T8

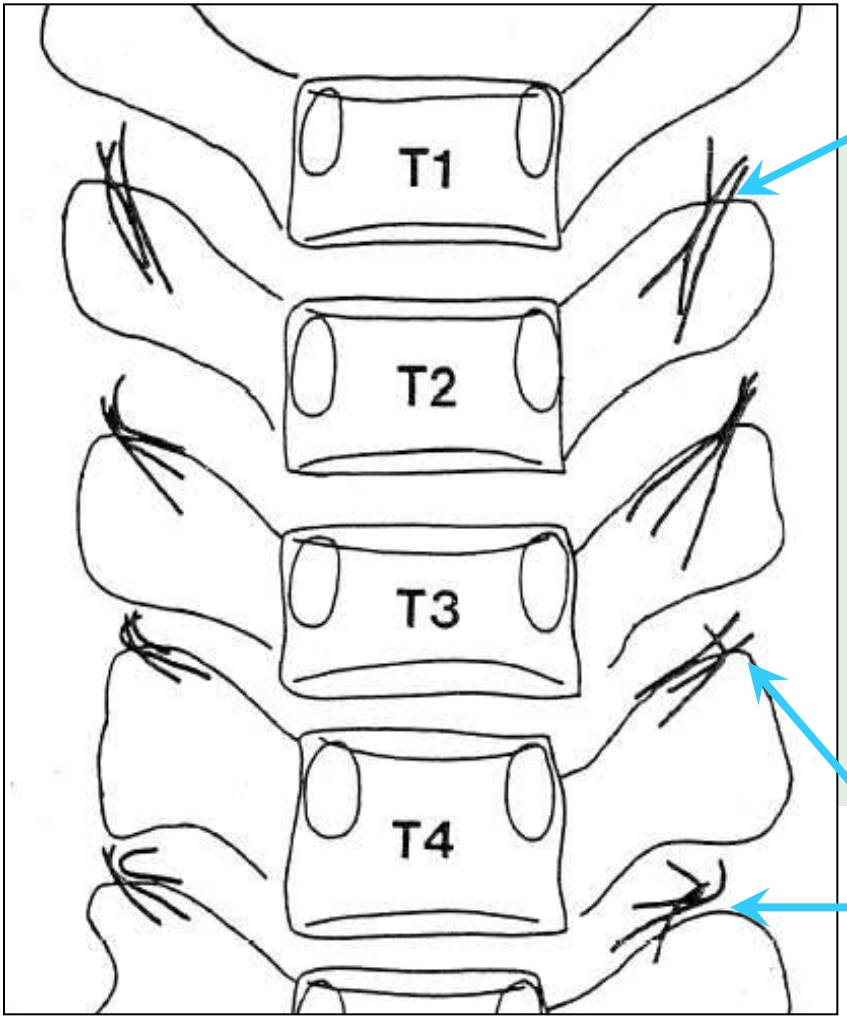
T1-T4 Medial Branches



Adapted from Fig 2.11 of Chua Thesis 1994

Cadaver dissections show that the T1-T4 medial branches cross the transverse processes at the superolateral corner.

T1-T4 Medial Branch Variability



Adapted from Fig 3.3 of Chua Thesis 1994

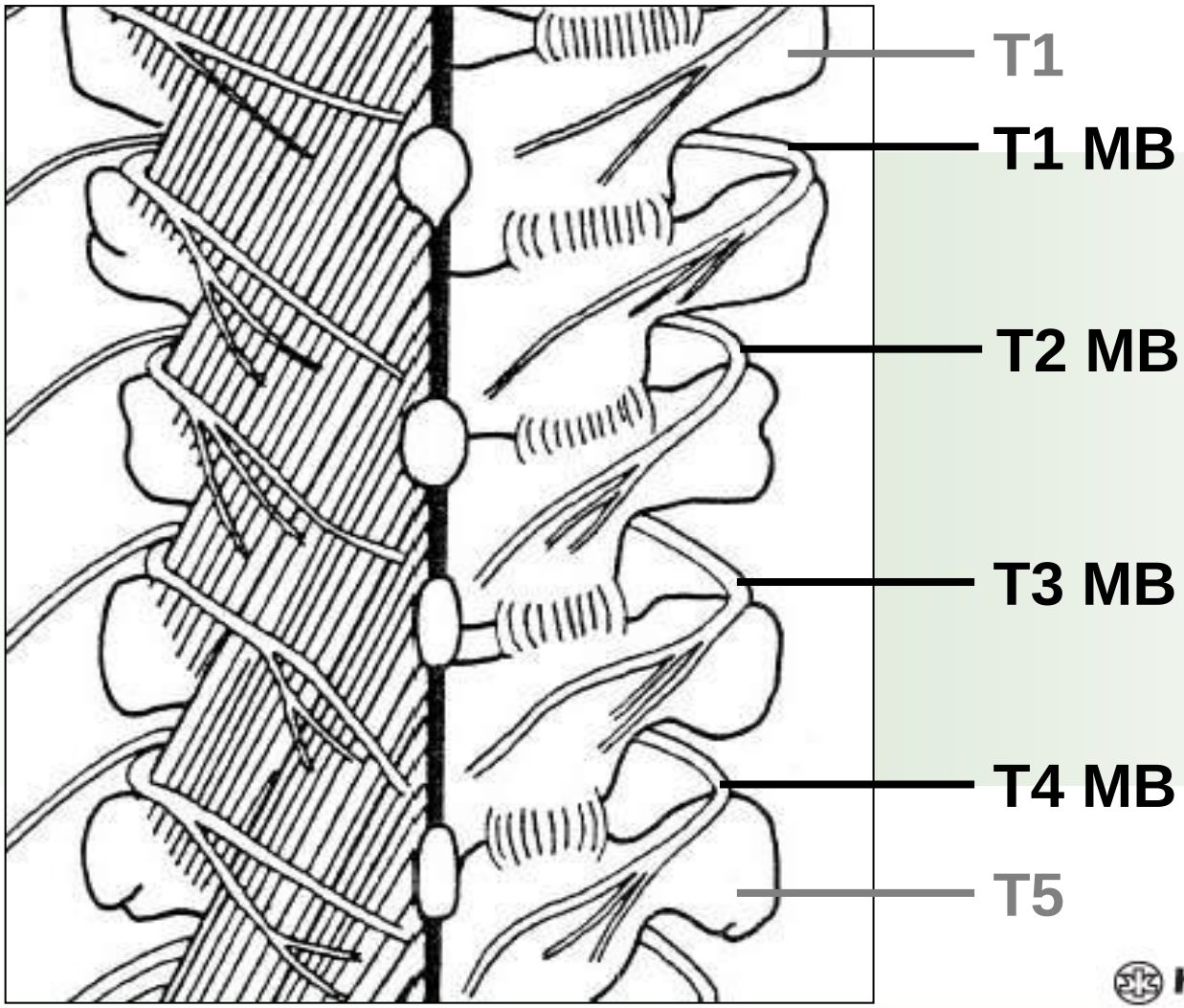
Superolateral corner of subjacent transverse process.

This point is visible on fluoroscopy, before the MB enters ligaments .

Variability between individuals is minimal for the T1-T4 MBs near the superolateral corner of subjacent transverse process.

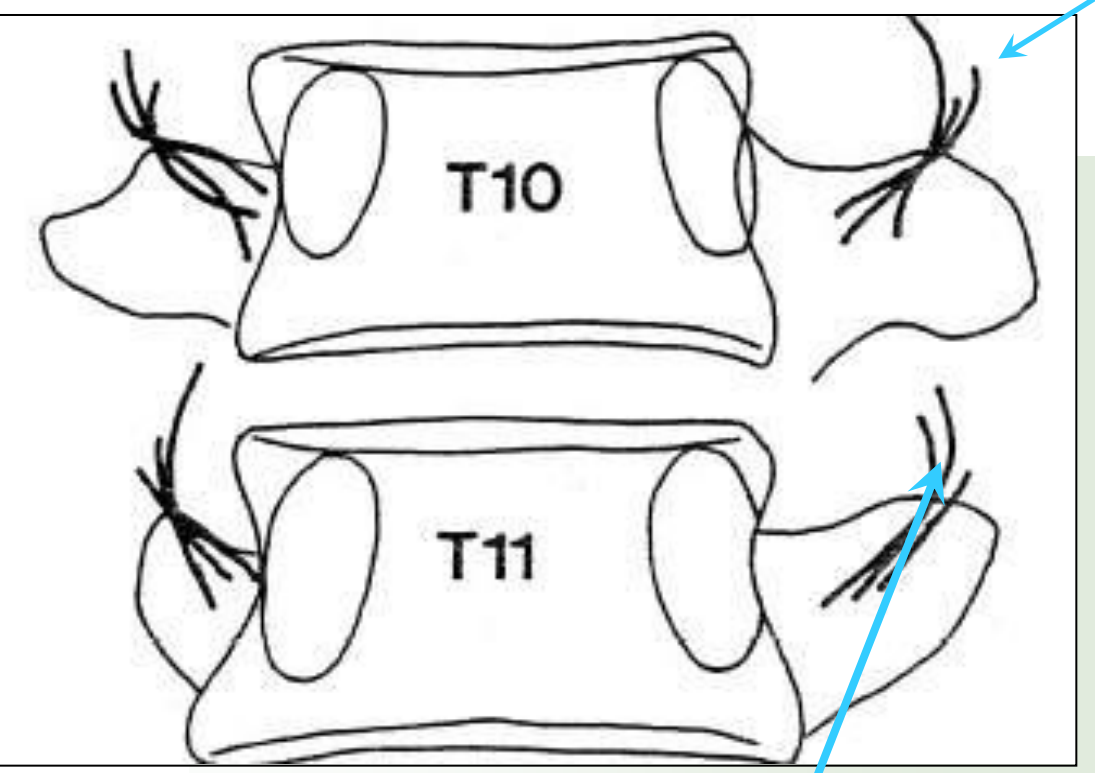
Note that variability decreases greatly near the bone surface.

General Expected Paths of T1-T4 MBs



Adapted from Fig 2.16 of Chua Thesis 1994

T9-T10 Medial Branch Variability



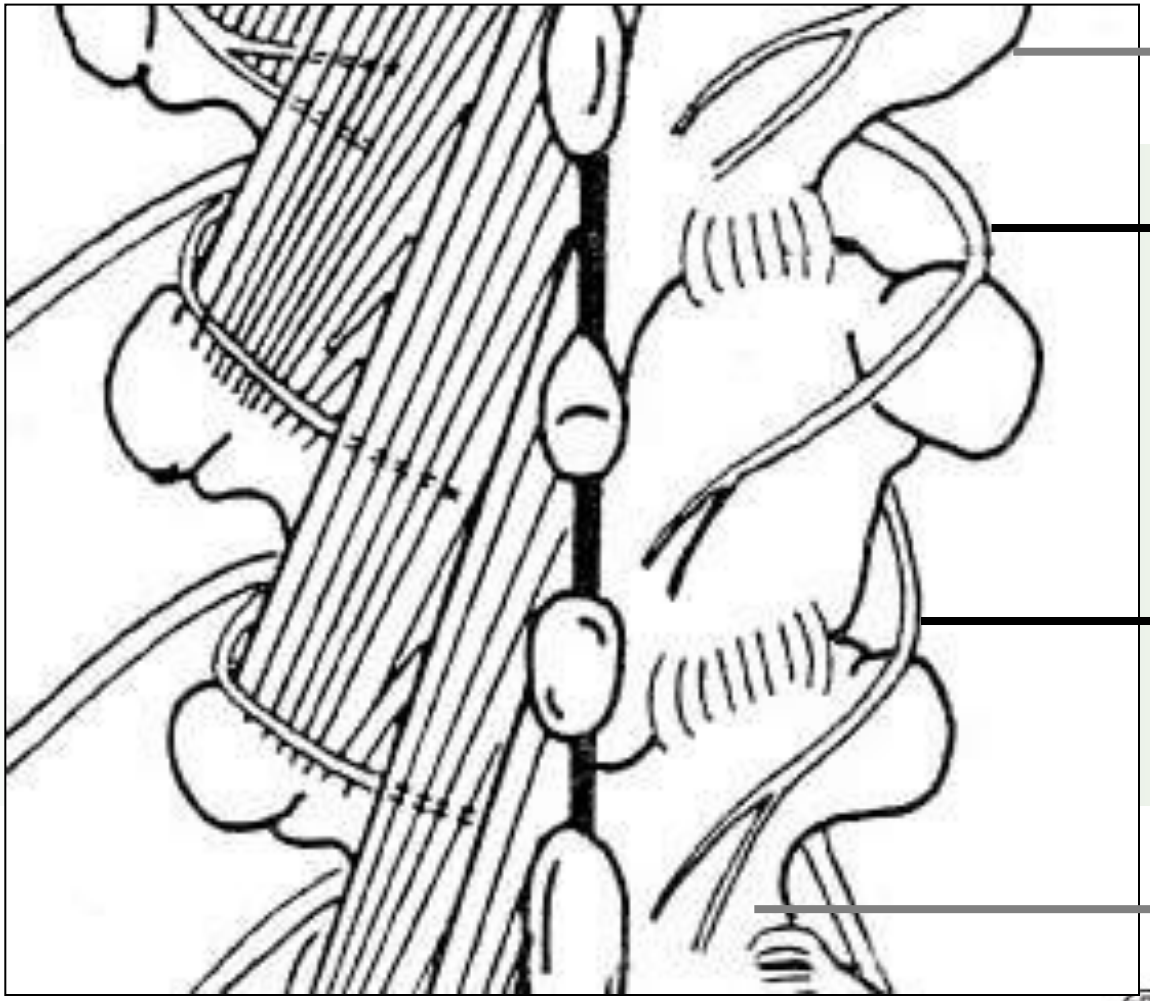
Adapted from Fig 3.3 of Chua Thesis 1994

Superolateral corner of subjacent transverse process (point visible with fluoroscopy)

Variability between individuals is minimal for the T9-T10 medial branches near the superolateral corner of subjacent transverse process.

Note that variability decreases greatly near the bone surface.

General Expected Paths of T9-T10 MBs

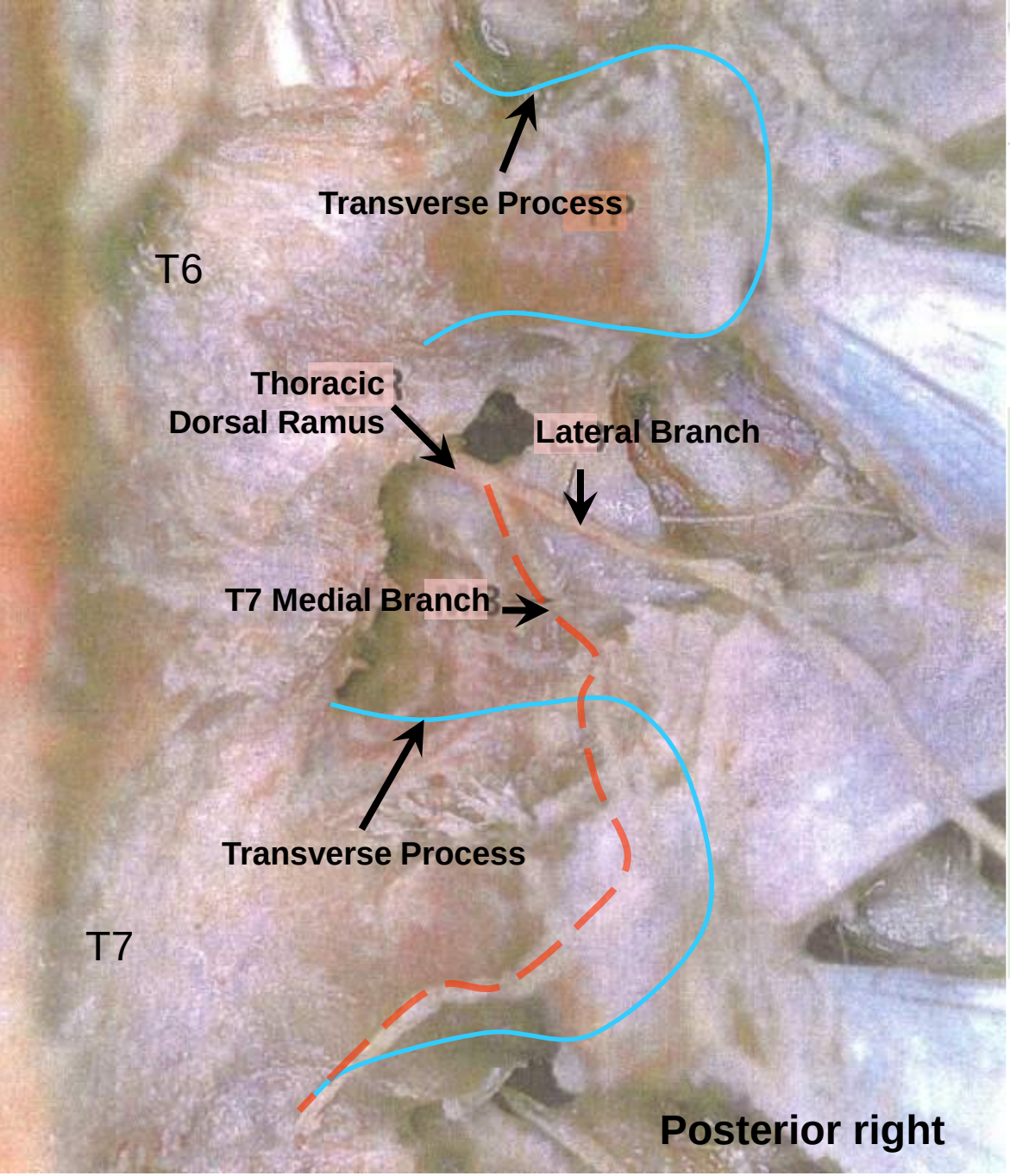


Adapted from Fig 2.16 of Chua Thesis 1994

T5-T8 Medial Branch

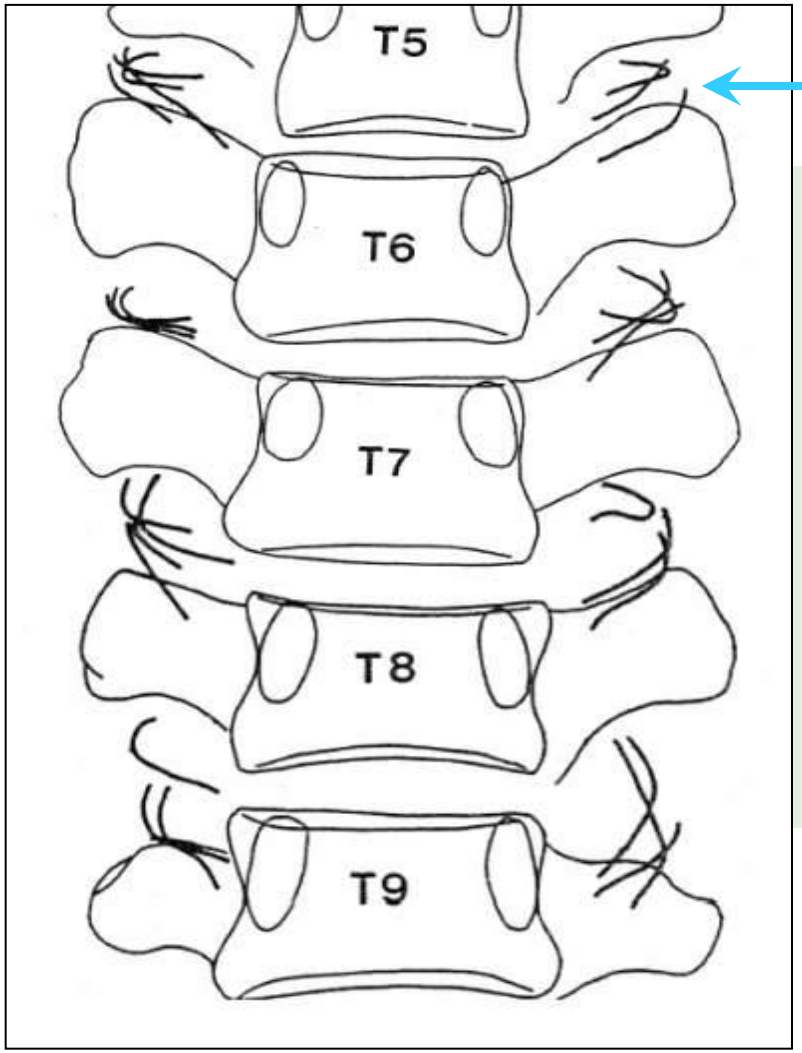
- At mid thoracic levels (T5-T8), the MB does not assume contact with the transverse process.
- The nerve appears suspended in the intertransverse space as it passes dorsally.
- It assumes a course parallel to those at typical levels, however T5-T8 medial branches are displaced superiorly.
- These branches then curve medially and slightly inferiorly, remaining separated from the transverse process by the fascicles of the multifidus.

T5-T8 MBs



Adapted from Fig 2.8 of Chua Thesis 1994

T5-T8 Medial Branch Variability



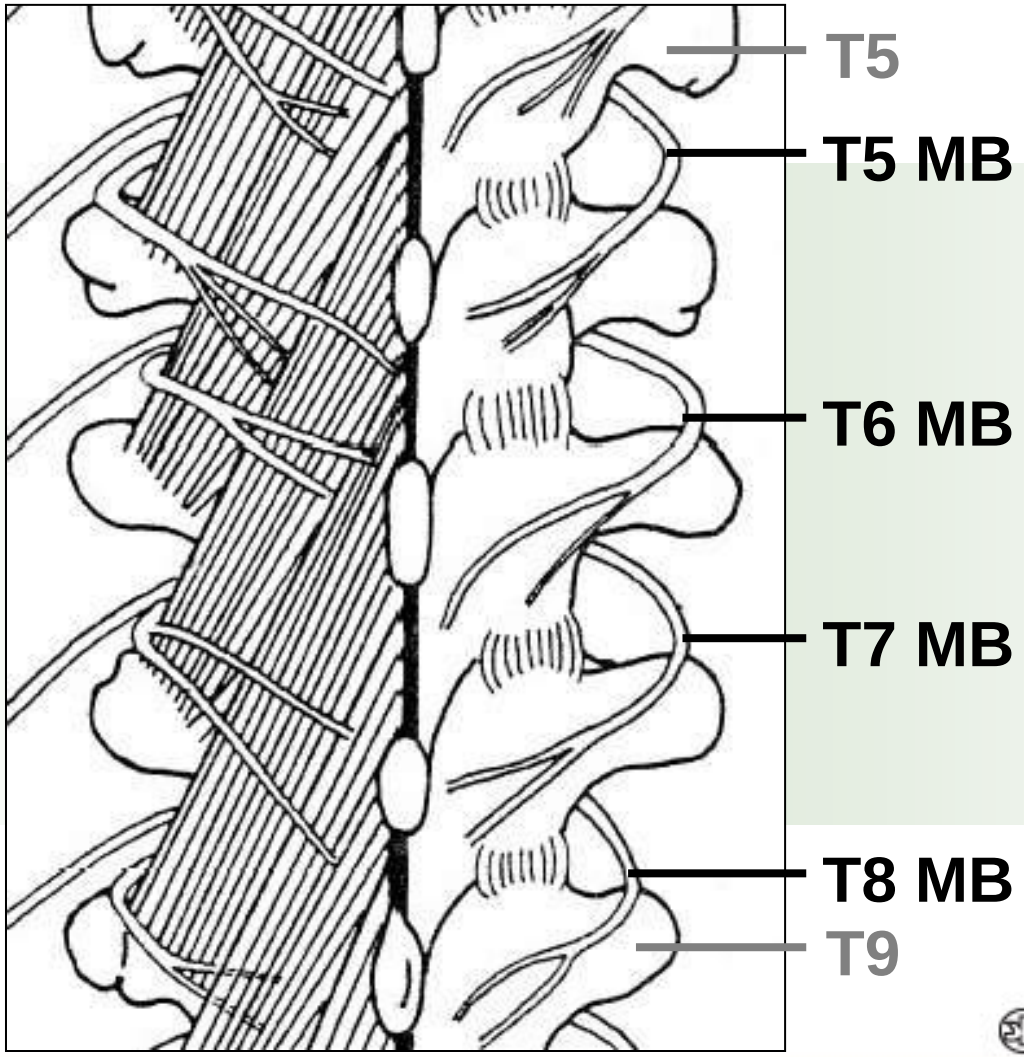
Adapted from Fig 3.3 of Chua Thesis 1994

Superolateral corner of subjacent transverse process. This point is visible on fluoroscopy, before the MB enters ligaments.

Variability between individuals is significant for the T5-T8 MBs near the superolateral corner of subjacent transverse process.

However, note that variability near the superolateral corner of the transverse processes is contained in the marked red circles.

General Expected Paths of T5-T8 MB

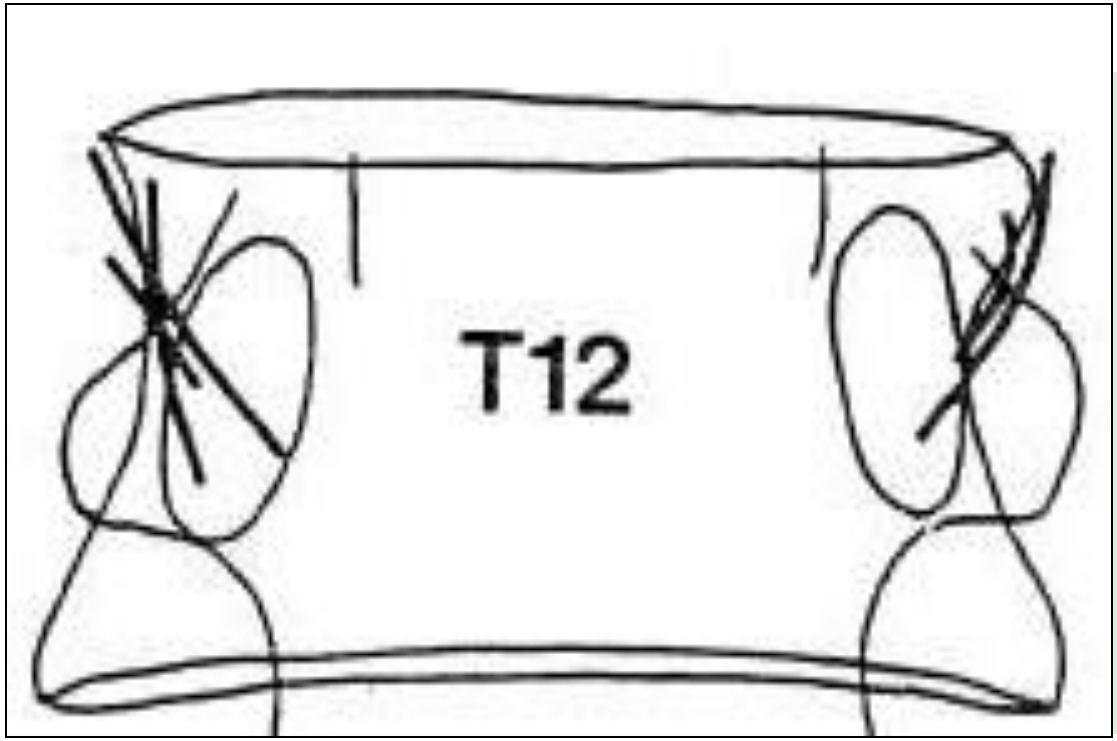


Adapted from Fig 2.16 of Chua Thesis 1994

T11 Medial Branch

- The T11 medial branch runs across the lateral surface of the root of the T12 superior articular process.

T11 Medial Branch

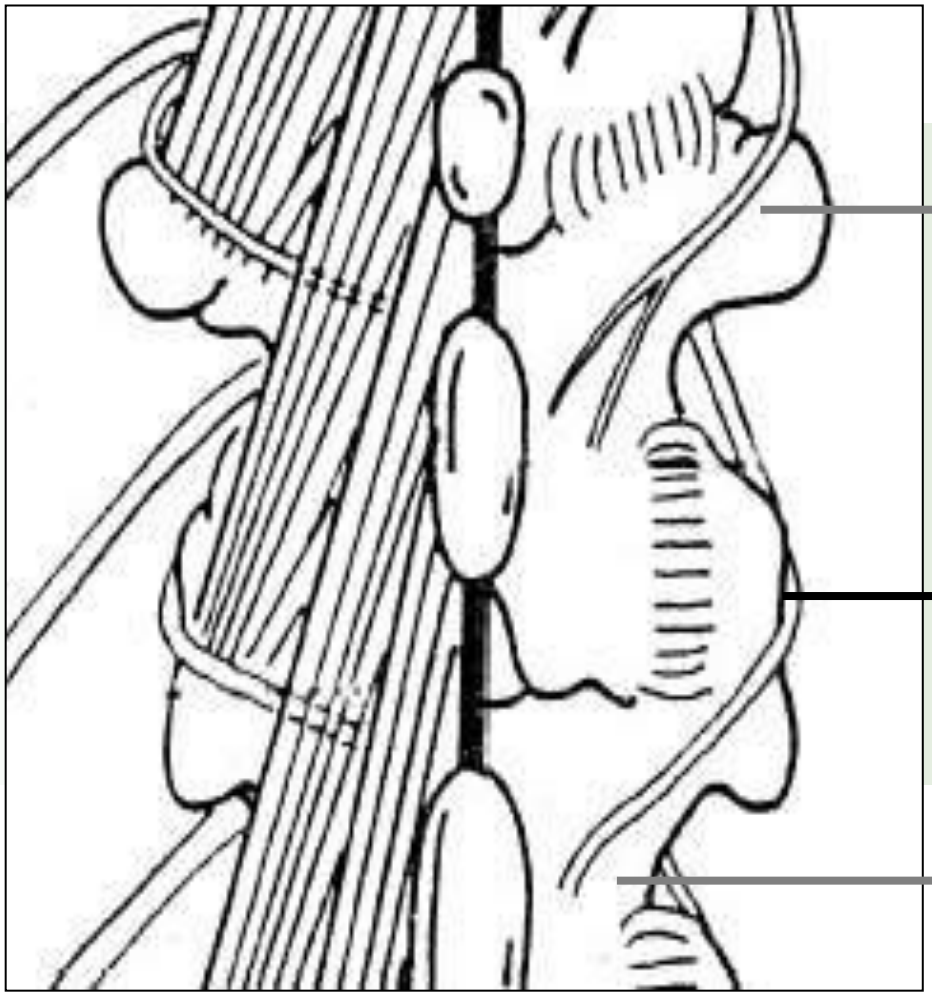


Adapted from Fig 3.3 of Chua Thesis 1994

Bony anatomy similar to lumbar region.

Variability between individuals is minimal for the T11 medial branches on subjacent transverse process.

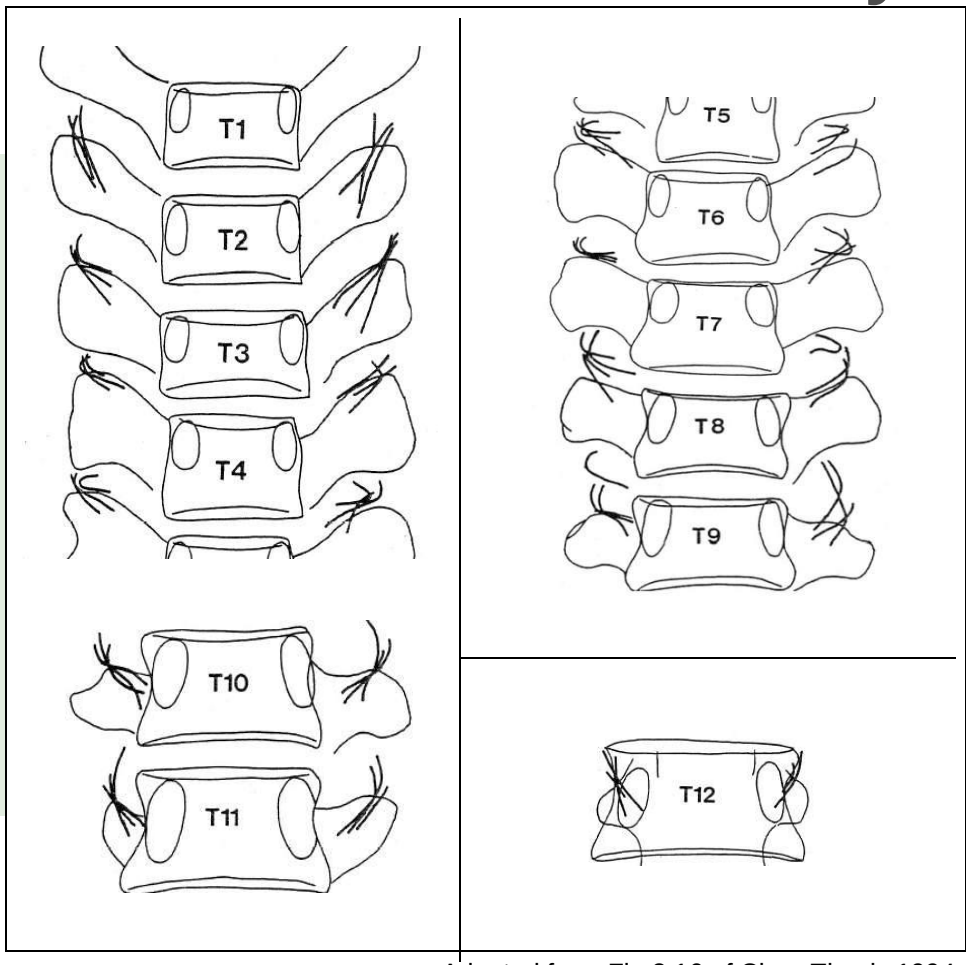
General Expected Path of T11 Medial Branch



Adapted from Fig 2.16 of Chua Thesis 1994

Summary of Medial Branch Neuroanatomy

- The MB of the thoracic dorsal ramus shows a variable course.
- Path of the MB is more predictable near the superolateral corner of subjacent transverse processes.



Adapted from Fig 2.16 of Chua Thesis 1994

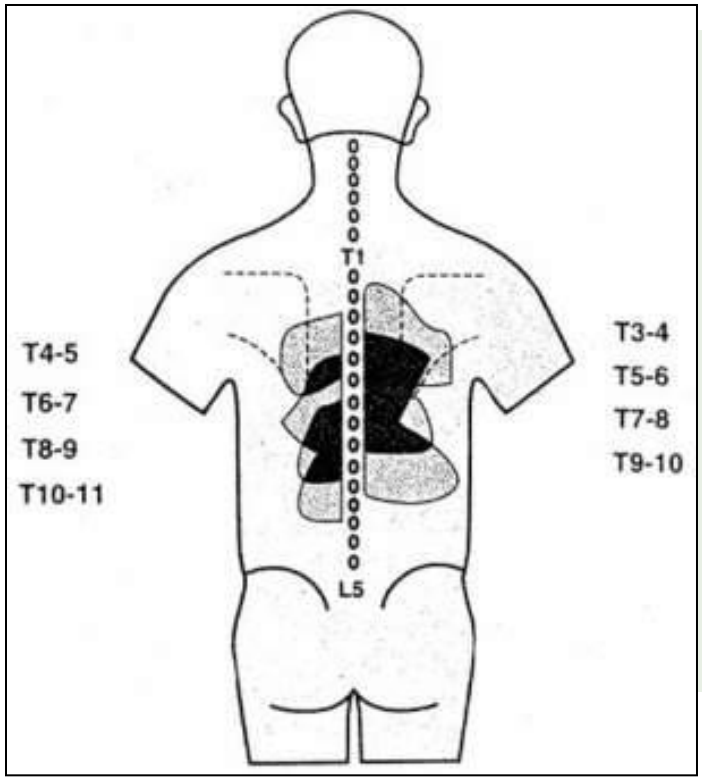
Diagnosis

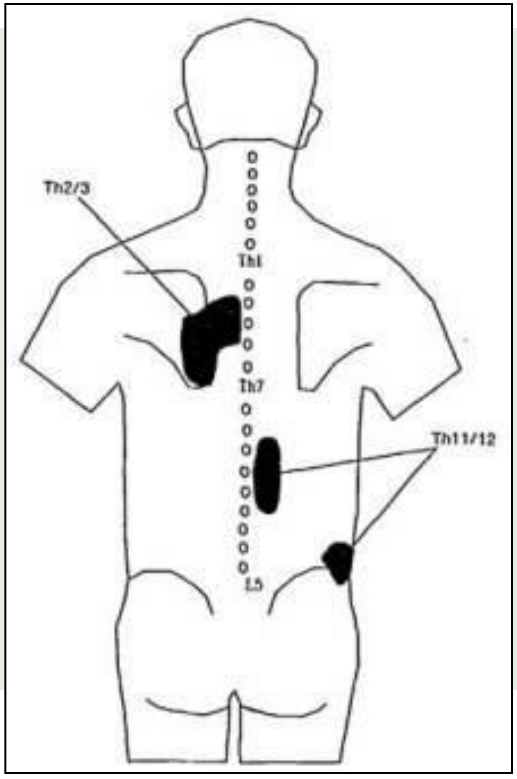
Sources of Thoracic Spinal Pain

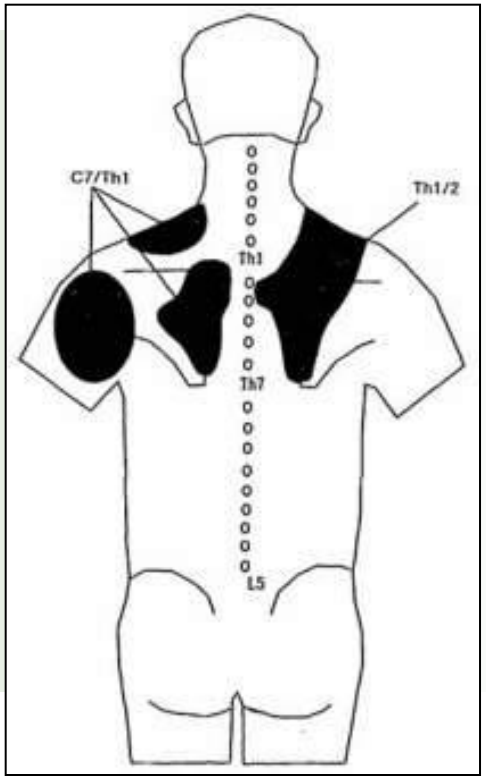
- Intervertebral disc
- Spinal dura mater
- Paravertebral muscles
- Ligaments
- Costovertebral joints
- Costotransverse joints
- Zygapophysial joints
- Nerve roots
- Dorsal ramus
- Osseous elements
- Sympathetic elements

Thoracic Zygapophysial Pain Pattern

- Significant overlap exists between thoracic segmental pain referral patterns







Adapted from Dreyfuss *et al.*, Spine 1994;19(7):807-11 (Fig.3) and Fukui *et al.*, Reg Anesth 1997;22(4):332-6 (Fig.1,2).

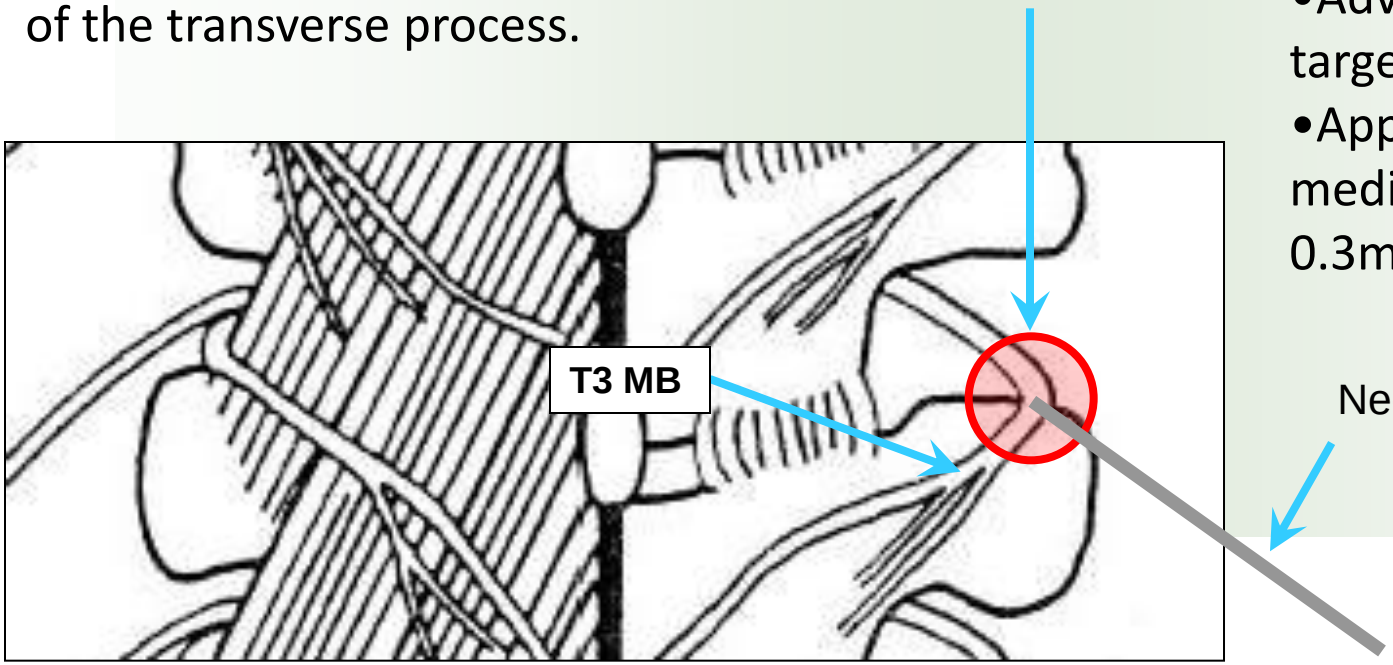
Patient Selection

- Predominantly axial pain between the T1 and L1 vertebrae
- Greater than 80% pain relief from two separate medial branch blocks (no more than 0.3 ml of injectate per block)
- Chronic axial pain lasting for longer than six months
- Failed conservative therapies
- All other sources of back pain have been ruled out

T1-T4 and T9-T10 Medial Branch Blocks

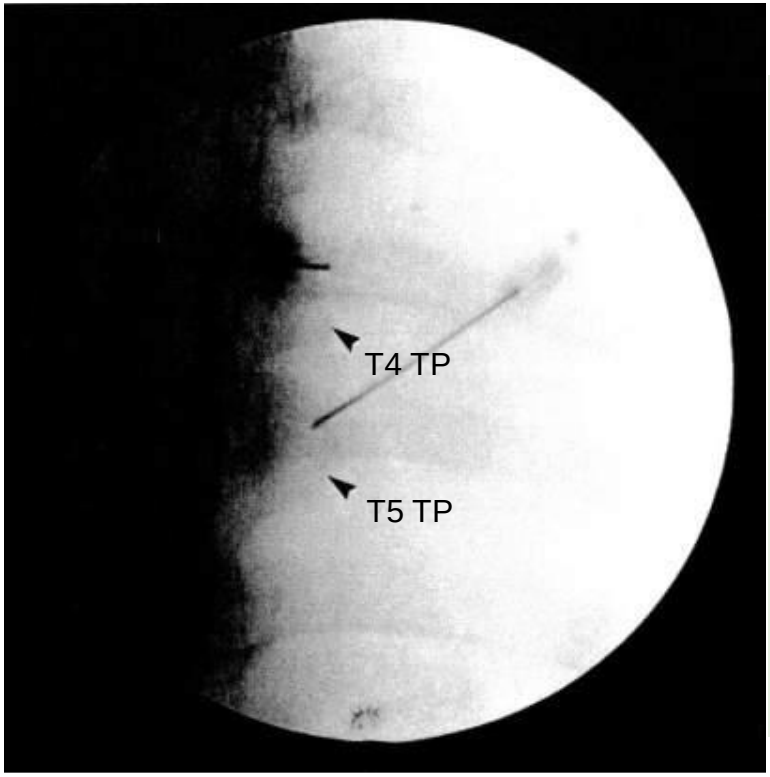
Target Point: Dorsal surface of the transverse process, opposite the lateral end of its superior border. This point lies just medical to the superior lateral corner of the transverse process.

Steps:
- Advance needle to target point.
- Apply 0.3ml contrast medium, followed by 0.3ml local anesthetic.

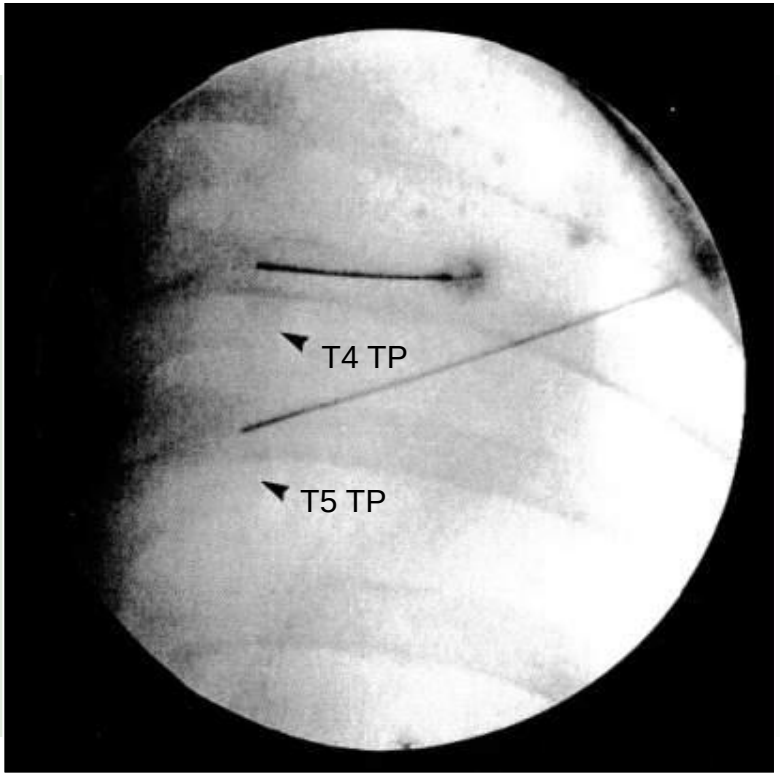


Adapted from Fig 2.16 of Chua Thesis 1994

T1-T4 and T9-T10 Medial Branch Blocks



Posterior Anterior View

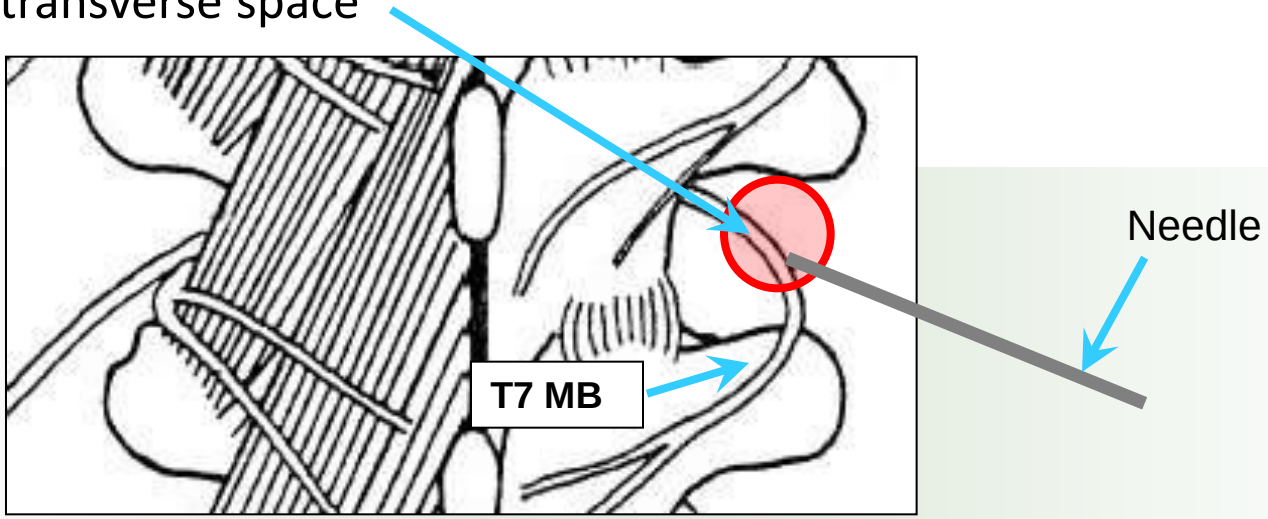


Oblique View

Adapted from Fig 4.1 (a) and 4.1 (b) of Chua Thesis 1994

T5-T8 Medial Branch Blocks

Target Point: Intertransverse space



Adapted from Fig 2.16 of Chua Thesis 1994

One-Needle Variation Steps:

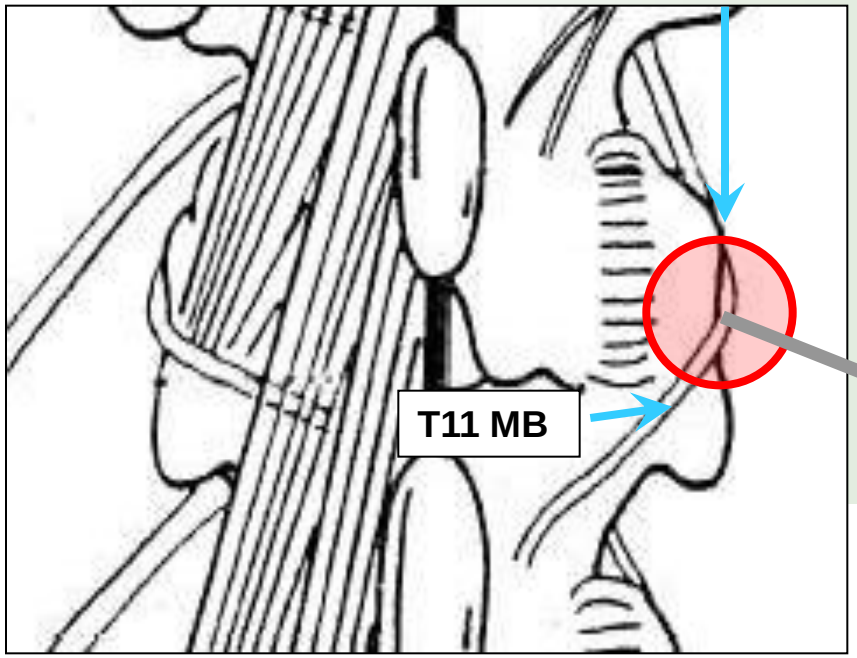
- Insert needle to upper edge of the dorsal surface of rib.
- Withdraw needle to the depth of the dorsal surface of the TP.
- Apply 0.3 ml contrast medium, followed by 0.3 ml local anesthetic.

Two-Needle Variation Steps:

- Insert needle onto dorsal surface of TP.
- Insert second needle onto upper edge of the dorsal surface of the rib and withdraw until the same depth as the first needle.
- Apply 0.3 ml contrast medium, followed by 0.3 ml local anesthetic.

T11 Medial Branch Blocks

Target Point: Anterior third of the junction between the root of the superior articular process and the root of the transverse process.



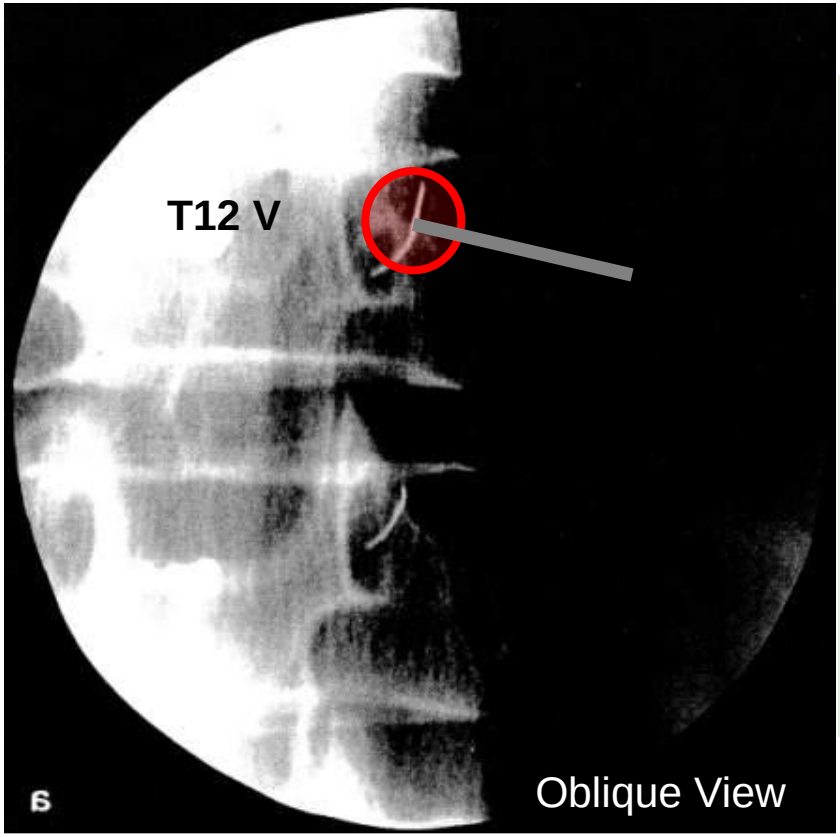
Adapted from Fig 2.16 of Chua Thesis 1994

Steps:

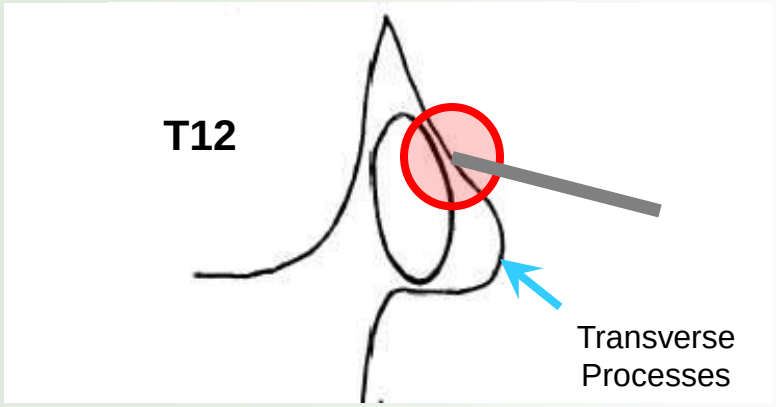
- Advance needle to target point.
- Apply 0.3 ml contrast medium, followed by 0.3 ml local anesthetic.

Needle

T11 Medial Branch Blocks



Adapted from Fig 4.6(a) and 4.6(b) of Chua Thesis 1994



"Scotty Dog" Diagram

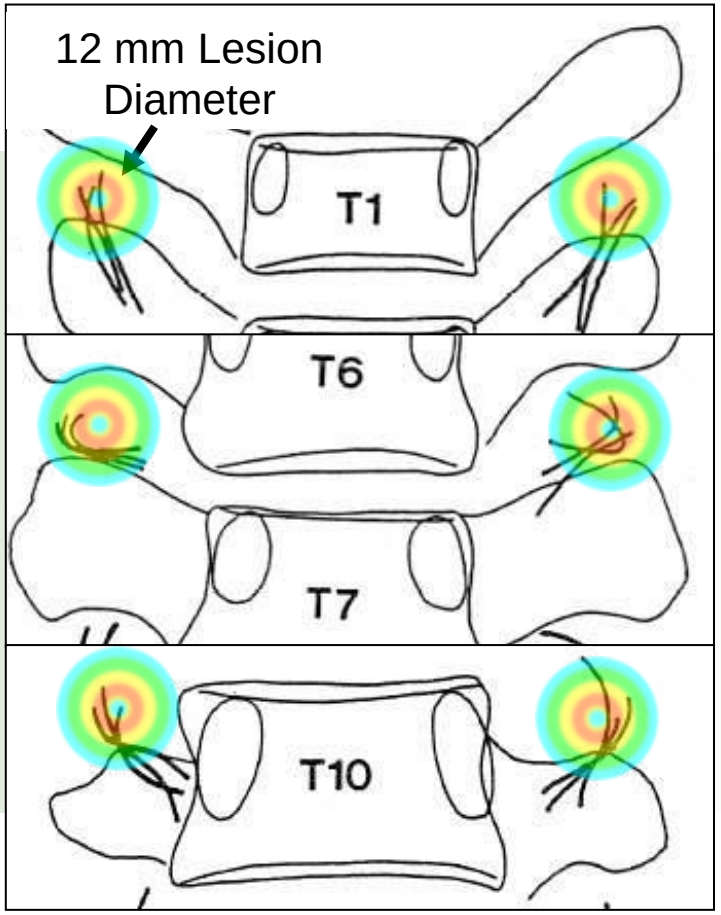
Cooled-RF Application

Criteria for Lesion

- Increase probability of ablating medial branch
  - Lesion must encompass variability of nerve path
- Target a known landmark easily visualized with fluoroscopy
- Similar to lumbar and cervical convention: Ablate medial branch before ramification (into z-joint, muscular and cutaneous branches)
- Heat affected area must reside away from sensitive structures
  - Nerve root, Pleura

Ideal RF Lesion Location

- Medial branch (MB) path is variable, but converges at superolateral corner of transverse process (TP).
- Superolateral corner of the TP is visible under fluoroscopy.



Adapted from Fig 3.3 of Chua Thesis 1994

Criteria for Needle Placement

- Introducer tip must be directed towards bone
- Procedure must use familiar imaging
- Procedure must use imaging to provide feedback with regards to depth of placement

Procedural Challenges

- Imaging and anatomy in thoracic region is less familiar
- Concern related to needle placement and pneumothorax
- Underdiagnosis of thoracic z-joint pain

  - Current treatment option does not meet needs of the variable anatomy

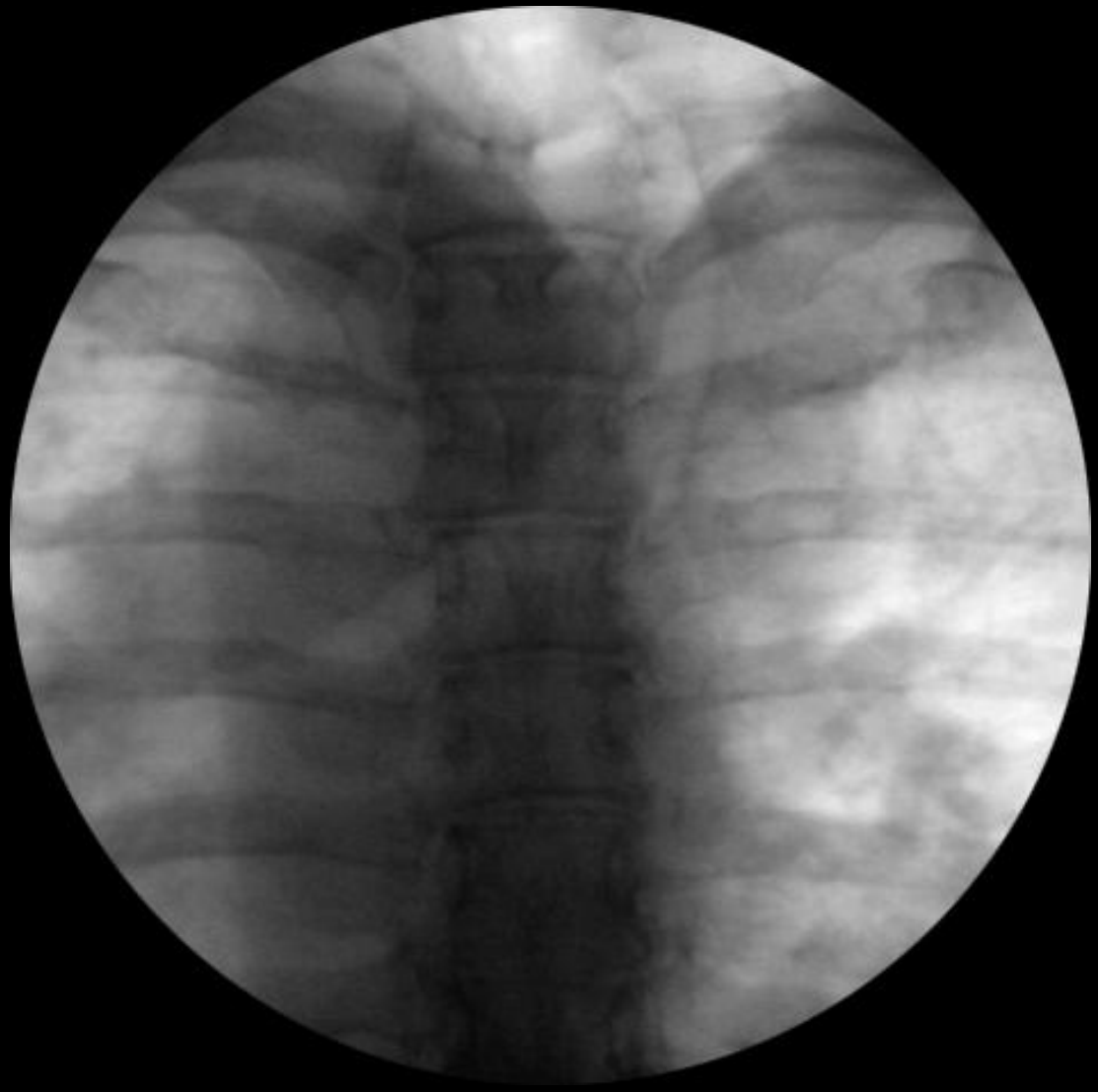
  - Variable anatomy can result in false negatives in diagnostic medial branch blocks

Procedural Approach

- Straightforward imaging
  - AP, lateral, ipsi- and contralateral oblique views
- Advance introducer towards the ‘thoracic safe zone’
  - Reduced risk of pleural puncture
- Approach constrains placement to target for ablation
  - Promotes procedural repeatability

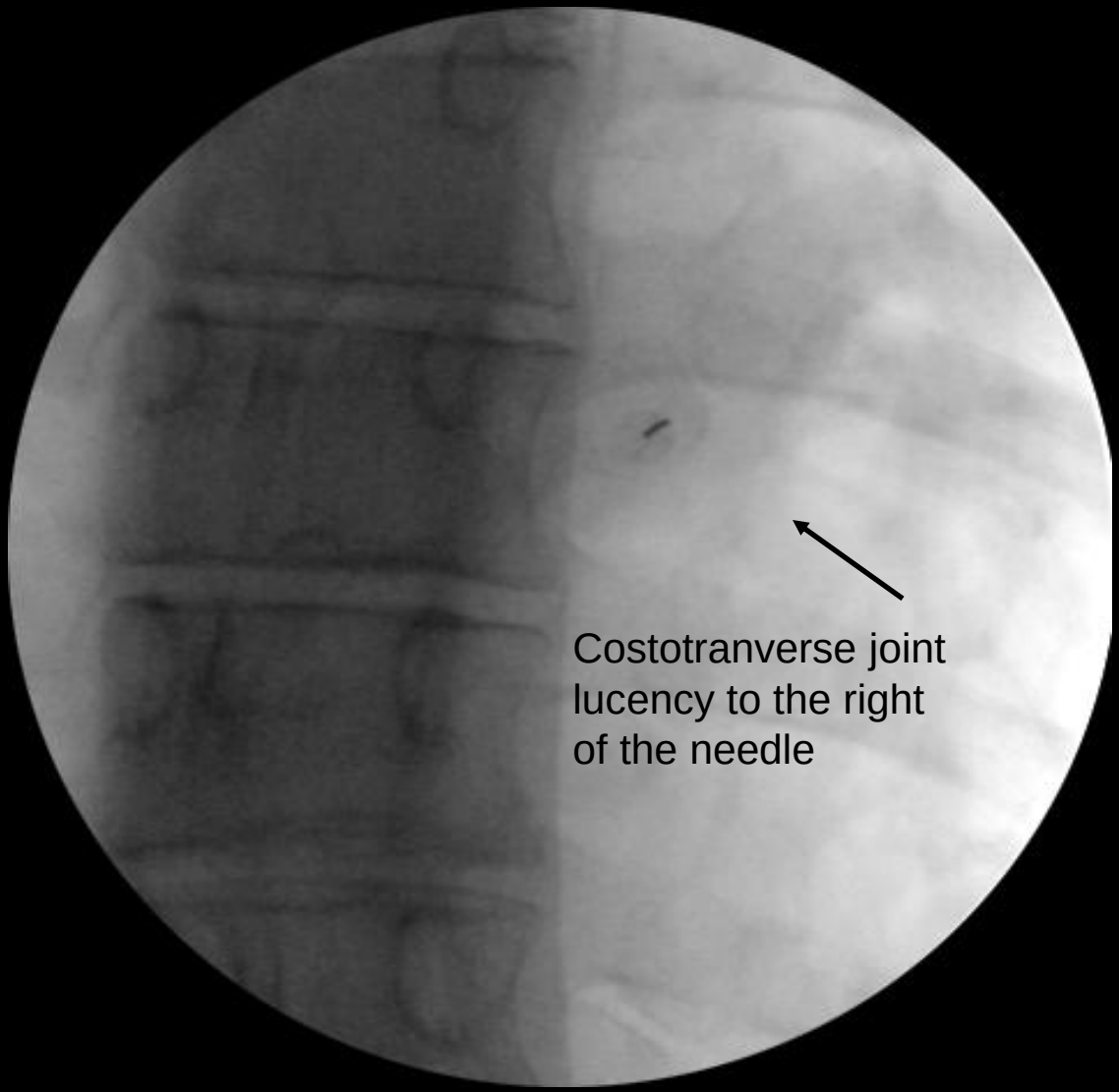
Step 1: Position C-arm in AP; locate treatment level

AP View



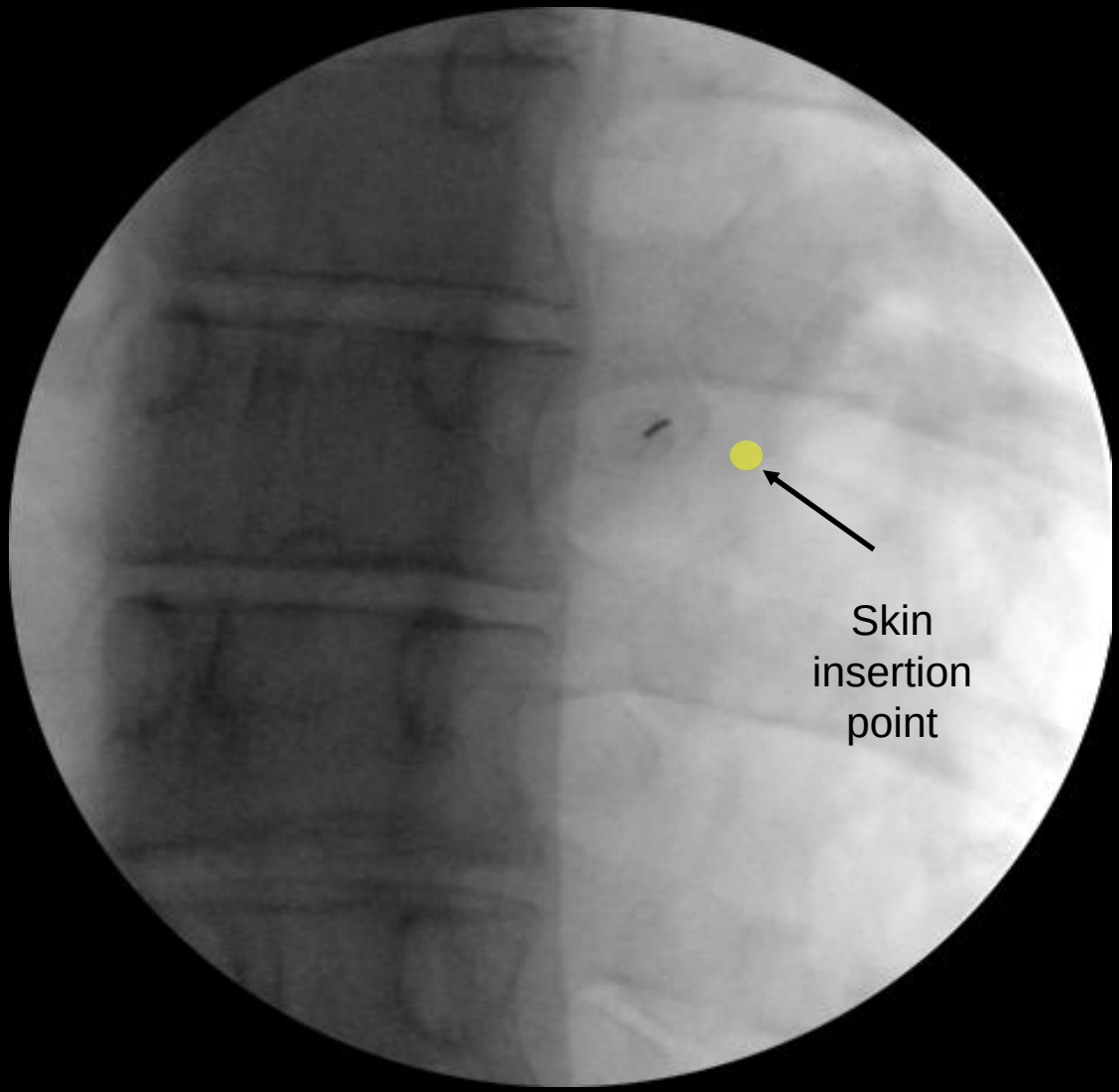
Step 2: Rotate C-arm ipsilateral oblique until the costotransverse joint lucency comes into view

Oblique View



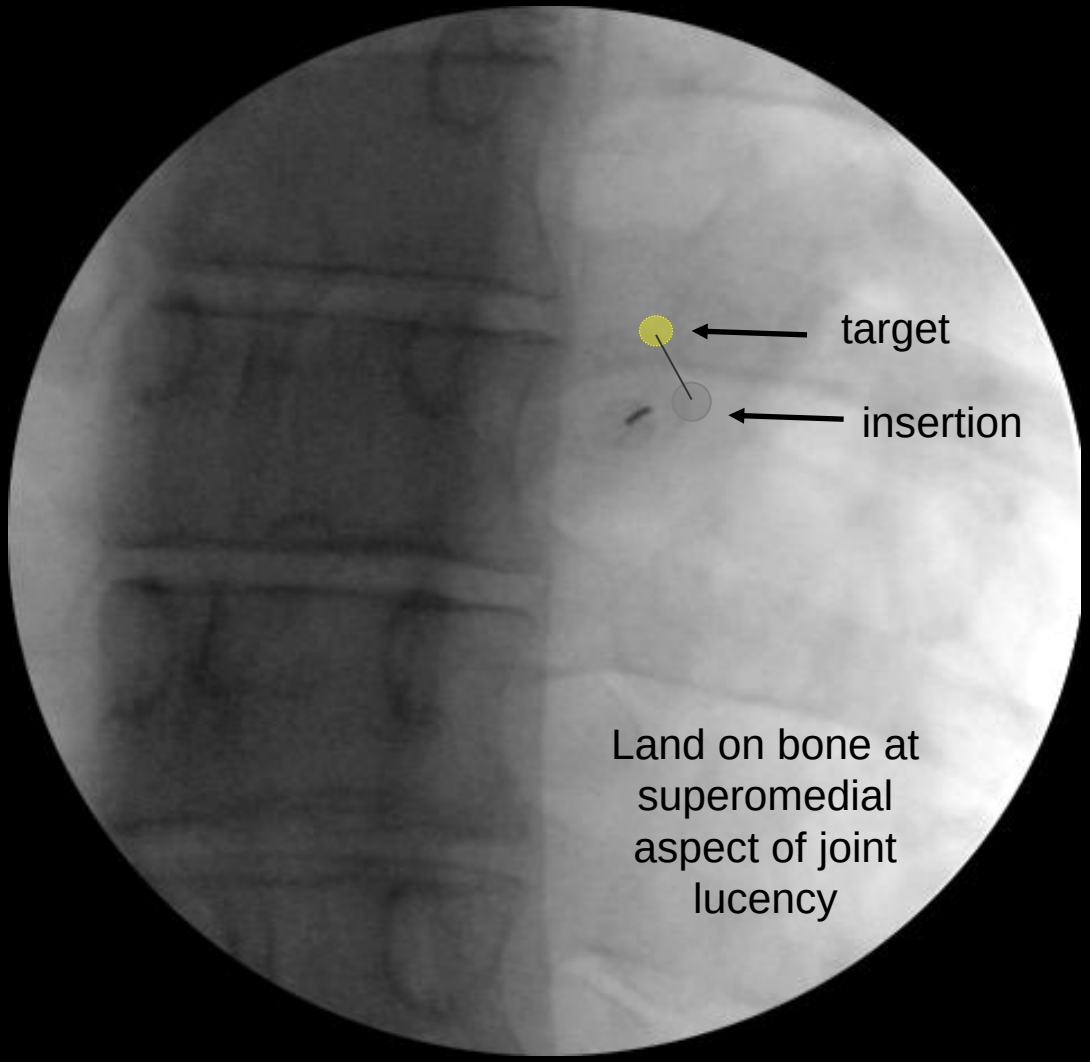
Step 3: Insert Introducer at inferolateral aspect of costotransverse joint lucency level

Oblique View



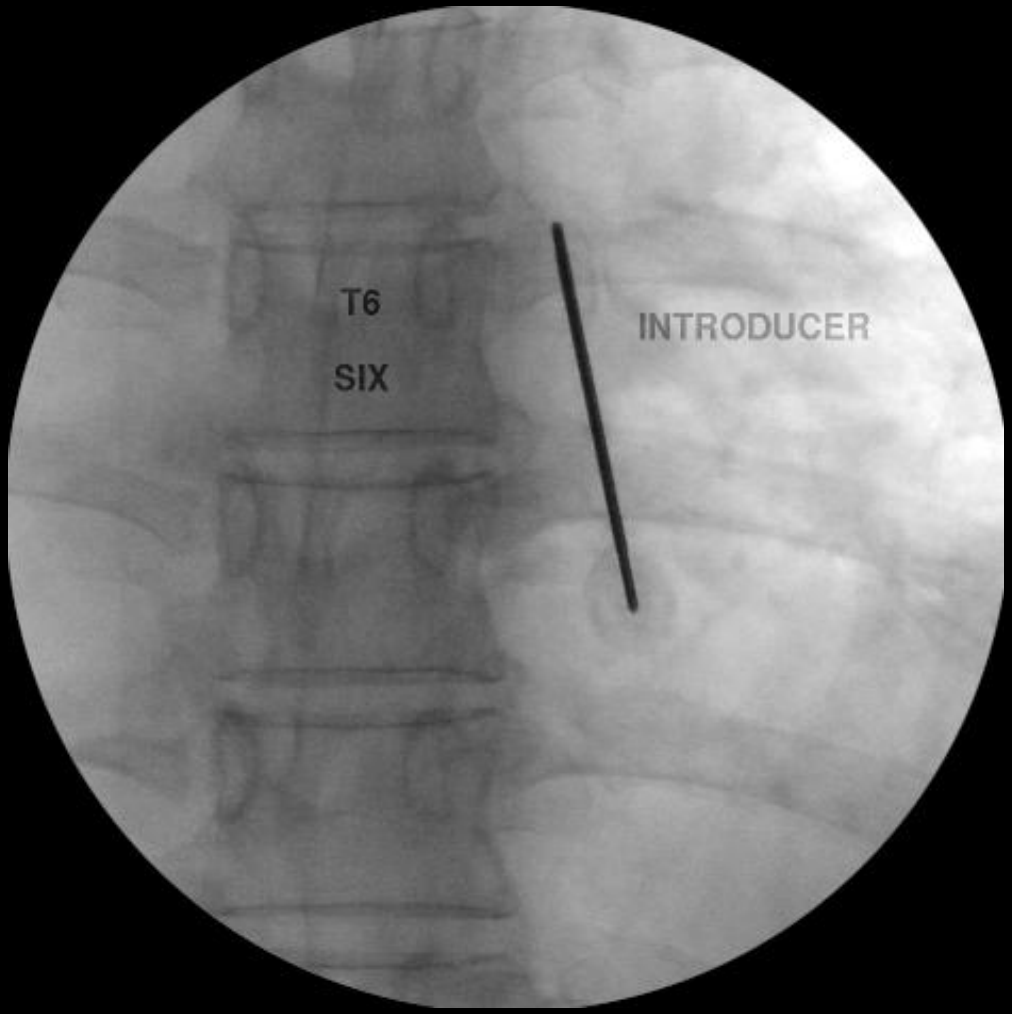
Step 4: Advance Introducer to superomedial aspect of costotransverse joint lucency

Oblique View



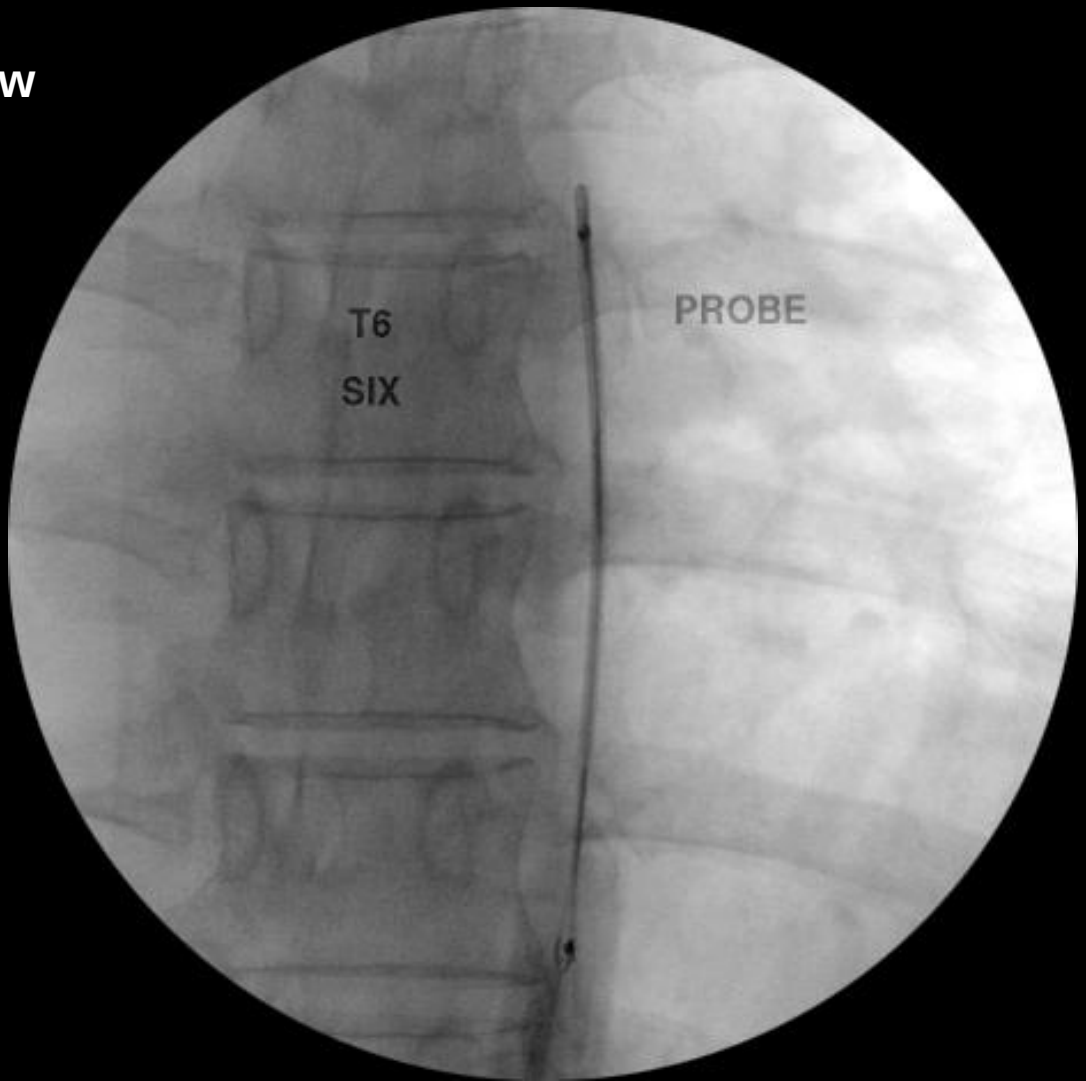
Step 5: Position C-arm in AP and walk stylet up to superior margin of transverse process

Oblique View



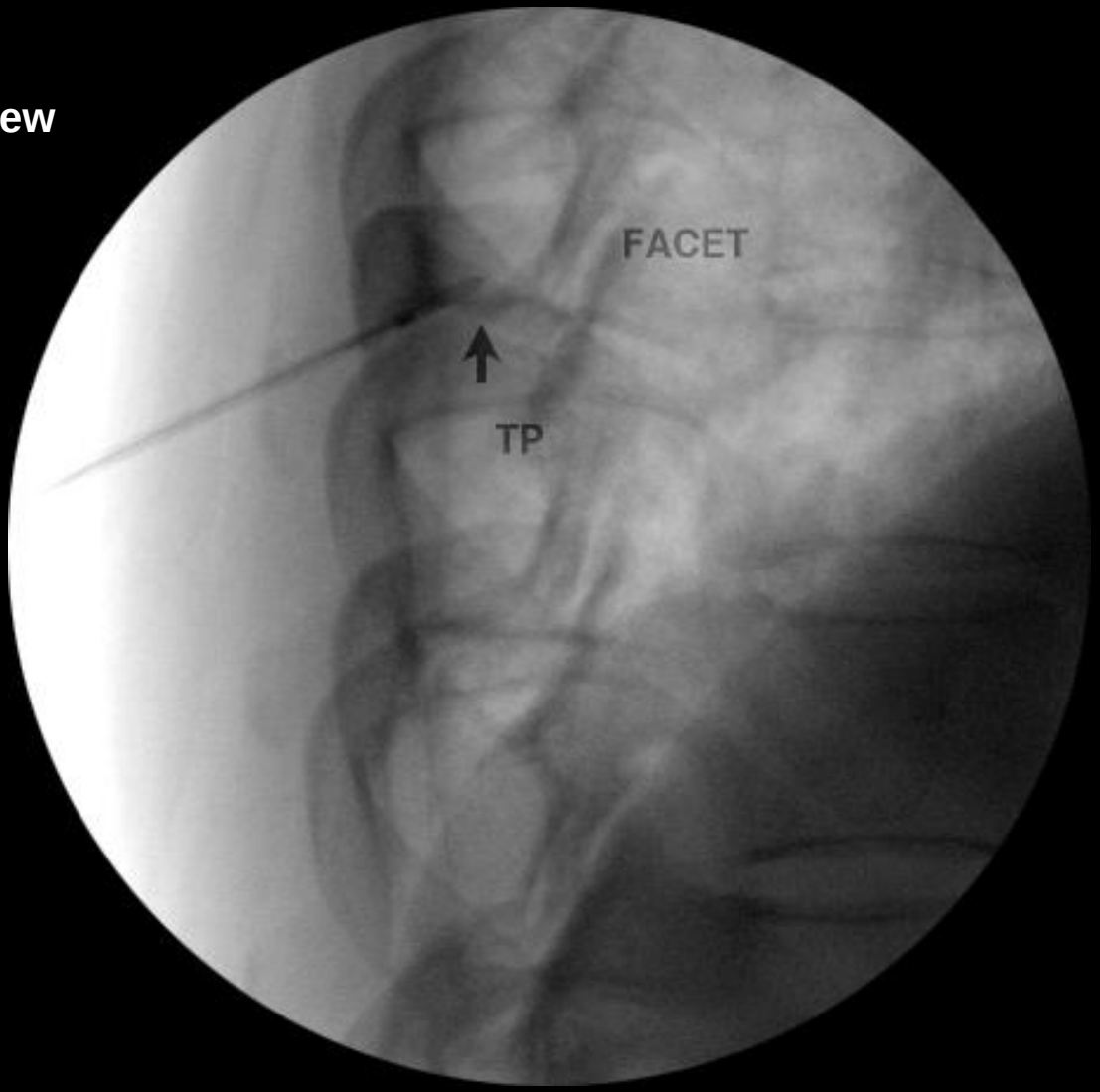
Step 6: Replace stylet with probe

Oblique View



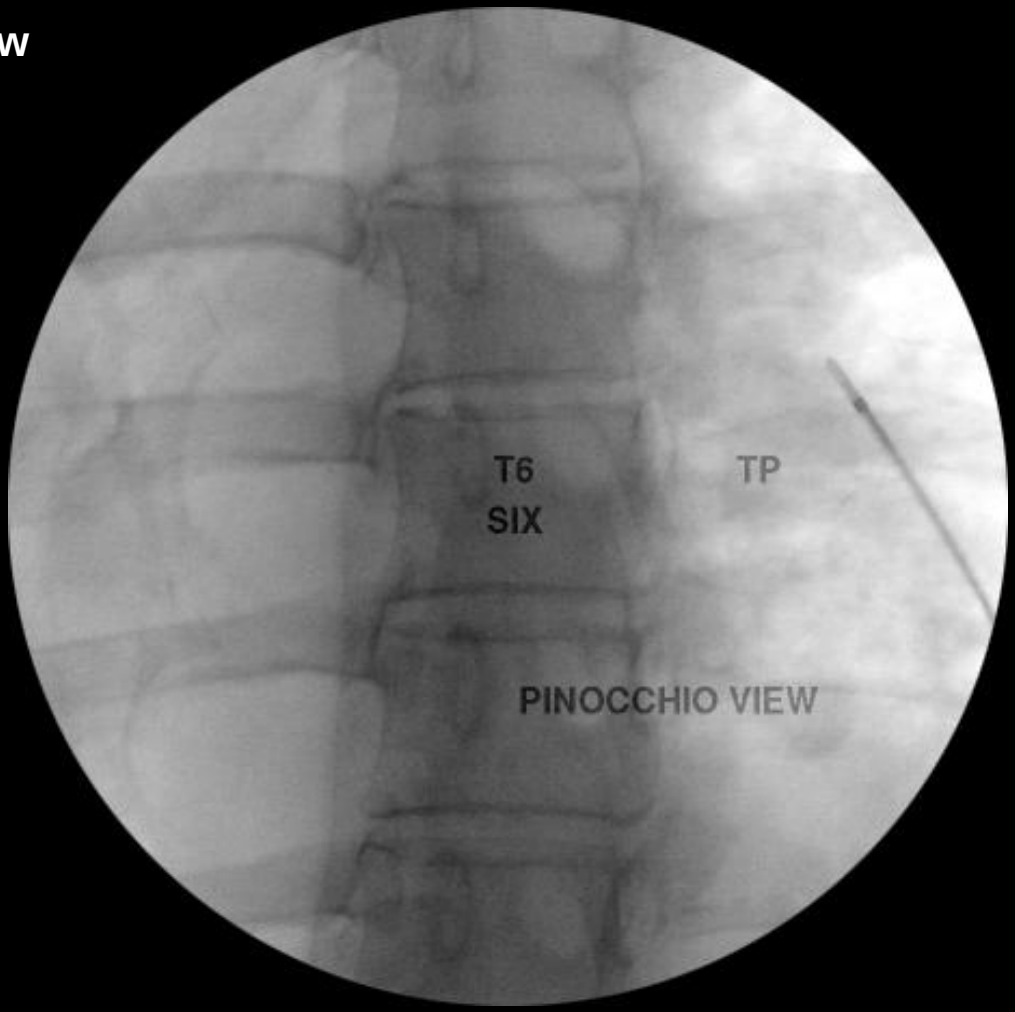
Step 7: Confirm depth on lateral

Lateral View



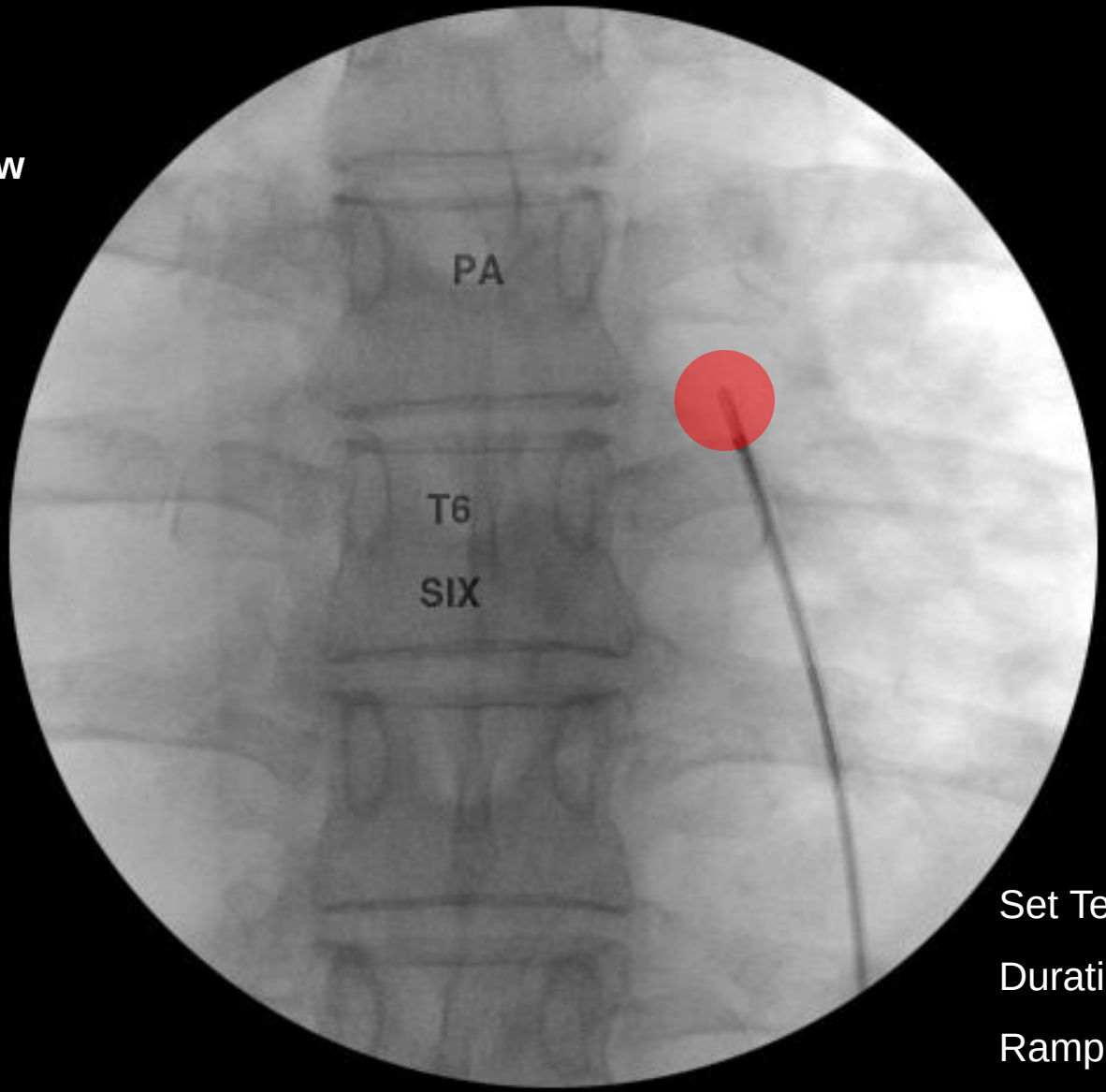
Step 8: Confirm placement in Pinocchio View

Pinocchio View



Step 9: Create Cooled RF lesion

AP View



Set Temp = 60°C

Duration = 2:30 min

Ramp = 80°C/min

Procedure Summary

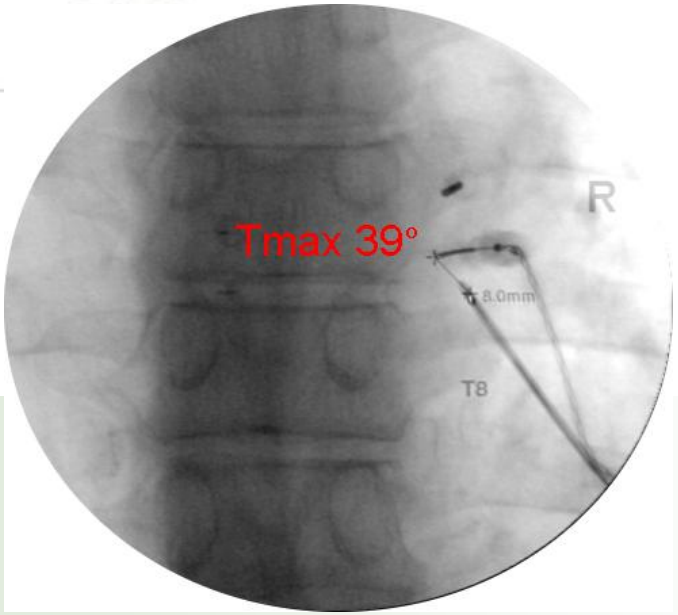
- Lateral to medial approach directs introducer tip towards vertebral body
- Ipsilateral oblique placement constrains lesion to superolateral aspect of transverse process
- Straightforward imaging aids in identifying transverse process
- Large, spherical lesion targets variability of nerve path
- One introducer insertion reduces iatrogenic injury to the patient

Description of a novel device, novel technique, in vivo temperature study, and 8 patient 6-month outcomes

R. E. Wright, S. Brandt, K. Allen, J. Wolfson. Pending Publication

Temperature *in vivo*

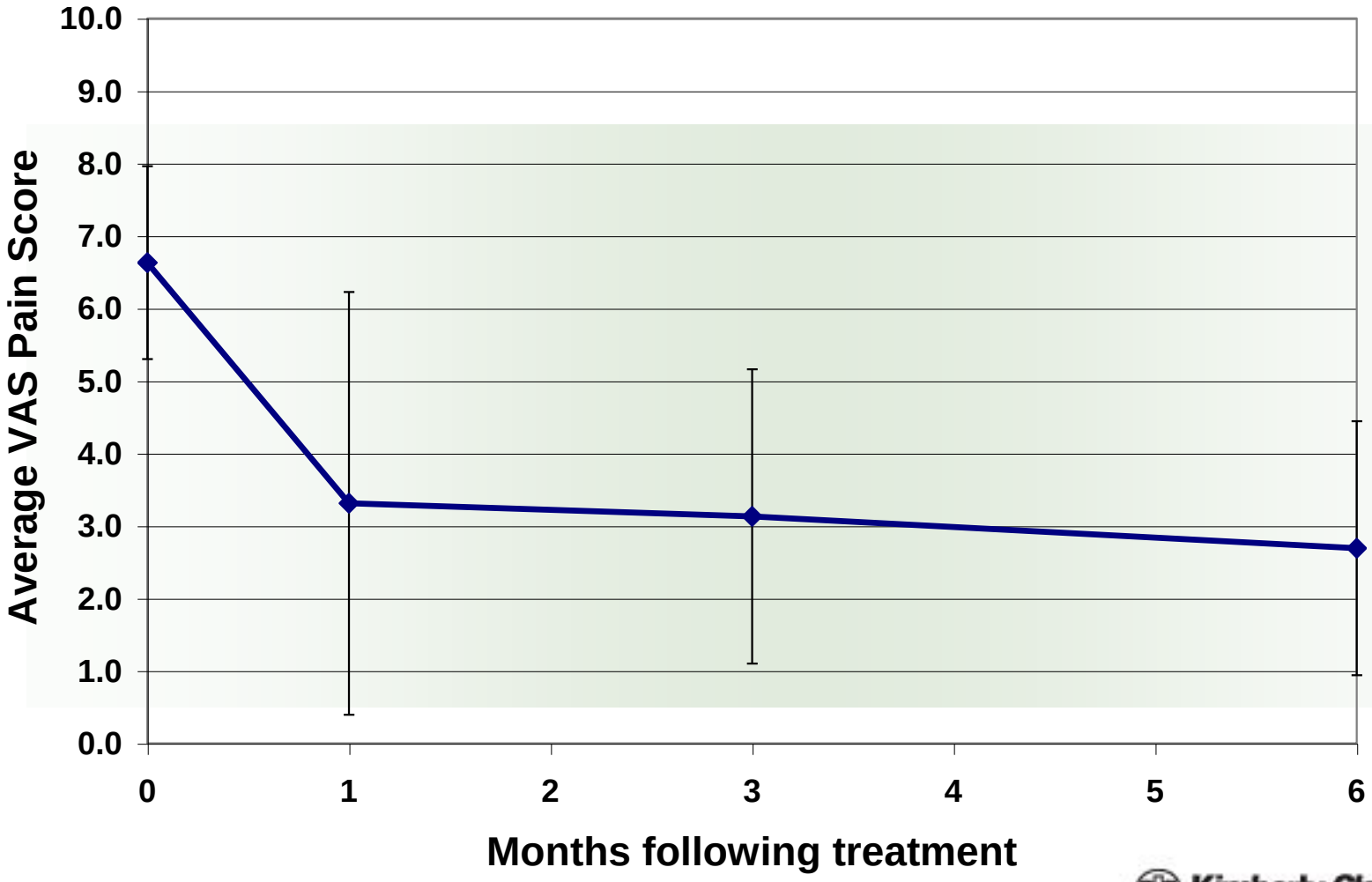
- Neuroablative temperatures are reached in the intertransverse space 6 mm from electrode (Smith, 1981)
- The zone of ablation measured spans 58% of the intertransverse space
- This zone encompasses the volume of tissue through which the medial branch is known to travel



Distance from Electrode (mm)	Temperature (°C)
3	71
4	57
5	55
6	47
8	39
23	37

Smith HP et al. J Neurosurg. 1981;55(2):246-53

Six-Month Average VAS Pain Score



Prospective Trial: 6-month outcomes

- 7/8 (88%) >50% pain relief
- 4/8 (50%) >10 pt or >50% drop in ODI
- 8/8 (100%) >10 pt improvement in SF-36 BP
- 6/8 (75%) >10 pt drop in SF-36 PF
- 3/8 (38%) Meds reduced
- 8/8 (100%) Satisfied (positive GPE)

ThoraCool Advantage

Safety

- Survey of anatomy shows no sensitive structures within target area.
- Advancing introducer towards Thoracic Safe Zone mitigates risk of pleural puncture.
- Obtaining both AP and lateral views confirms location of the introducer tip.

Efficacy

- Large, spherical, Cooled-RF lesion increases probability of successful medial branch ablation even with variability in nerve path.
- Placement on bony landmark (transverse process) provides repeatability for procedure.